CANADIAN ELECTRONICS ENGINEERING

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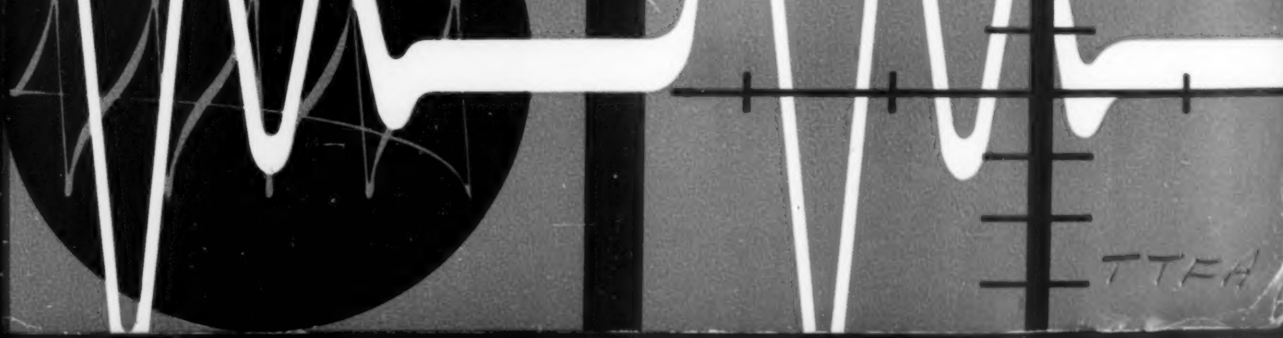


You Get MORE with

Canadian Marconi

MORE

CHANNELS - 132
POWER - 20 watts
ECONOMY
RELIABILITY
BACK-UP SERVICE
EXPERIENCE

and the DQ48

GENERAL PURPOSE MULTI-CHANNEL RADIO RELAY EQUIPMENT

Designed for Telephone Companies, Common Carriers, public utilities and all users of microwave systems, the DQ48 offers unique advantages.

Built for operation in the 900 Mc/s band, this equipment gives the propagation advantages that higher frequencies cannot give: at the same time presents no serious difficulty as regards frequency allocations.

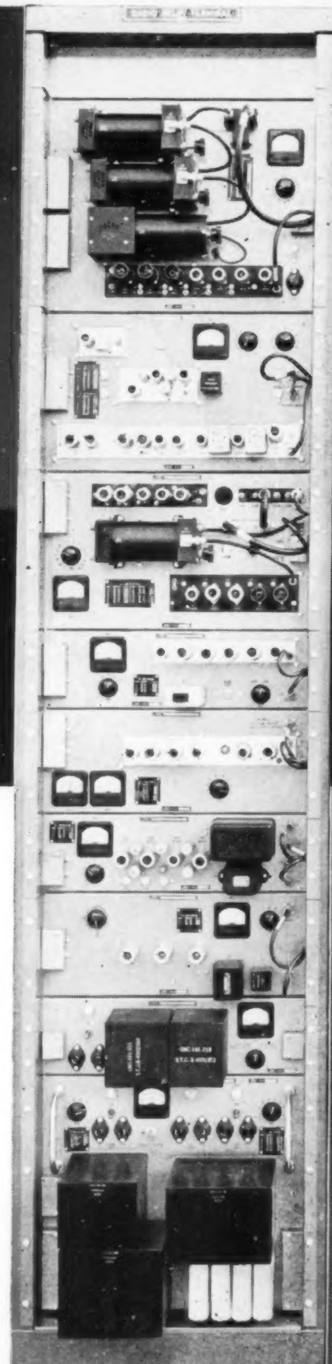
The high output power of the DQ48 combined with this frequency advantage virtually eliminates difficulties with fading and makes diversity operation unnecessary except in rare and unusual cases.

CMC is in a position to meet any and all of your requirements for a multi-channel radio relay system.

CMC does the whole job — basic planning, construction and installation of comprehensive systems, maintenance, personnel training and operation. Call on Marconi — with confidence.

CMC radio relay equipment is entirely designed and manufactured in Canada.

Write for technical brochure DQ48/D1



Transmitter/Receiver Rack used at terminals and repeaters.

CANADIAN MARCONI COMPANY — CMC CANADIAN MARCONI COMPANY — MONTREAL 16, CANADA

Cable Address: ARCON — CRescent 6-3627

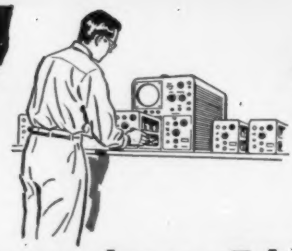
February 1958

Volume two, number 2

CANADIAN ELECTRONICS ENGINEERING

***our cover design** *Oscilloscope waveforms, together with the graticule mask of the tube, have been combined into an interesting design for our feature article*

You get MORE out of your oscilloscope investment..... when you choose a Tektronix Oscilloscope with the Plug-in Feature



Here's why: When you purchase your oscilloscope you can select one or more plug-in units, depending on your exact needs for the immediate future. Then, when an unexpected requirement develops – for instance, extremely-low-level work – you can purchase the appropriate plug-in unit at modest cost . . . in this case a Type 53/54E at only $165. With the present total of eleven available plug-in units, you are still able to enter any of several other highly-specialized application areas with the same oscilloscope, for just the cost of the appropriate plug-in unit.

Your Tektronix Field Engineer or Representative will be happy to supply you with complete specifications on these oscilloscopes and plug-in units, and arrange a demonstration in your particular application.

CHARACTERISTICS OF TYPE 53/54 PLUG-IN PREAMPLIFIERS

Plug-In Unit	Risetime of Combination —plugged into Type 541-545	531 535-536	532	Passband of Combination —plugged into Type 541-545	531 535-536	532	Calibrated Deflection Factor	Input Capacitance	Price
Type 53/54A Wide-Band DC	0.018 μsec	0.035 μsec	0.07 μsec	dc to 20 mc	dc to 10 mc	dc to 5 mc	0.05 v/cm to 20 v/cm	47 μμf	$ 85
Type 53/54B Wide-Band High-Gain	0.03 μsec	0.04 μsec	0.07 μsec	2 c to 12 mc	2 c to 9 mc	2 c to 5 mc	5 mv/cm to 0.05 v/cm	47 μμf	$125
	0.018 μsec	0.035 μsec	0.07 μsec	dc or 2 c to 20 mc	dc or 2 c to 10 mc	dc or 2 c to 5 mc	0.05 v/cm to 20 v/cm		
Type 53/54C Dual-Trace DC	0.015 μsec	0.035 μsec	0.07 μsec	dc to 24 mc	dc to 10 mc	dc to 5 mc	0.05 v/cm to 20 v/cm	20 μμf	$275
Type 53/54D High-Gain DC Differential	0.18 μsec	0.18 μsec	0.18 μsec	dc to 2 mc	dc to 2 mc	dc to 2 mc	1 mv/cm to 50 v/cm	47 μμf	$145
Type 53/54E Low-Level AC Differential	6 μsec	6 μsec	6 μsec	0.06 cycles to 60 kc	0.06 cycles to 60 kc	0.06 cycles to 60 kc	50 μv/cm to 10 mv/cm	Approximately 50 μμf	$165
Type 53/54G Wide-Band DC Differential	0.018 μsec	0.035 μsec	0.07 μsec	dc to 20 mc	dc to 10 mc	dc to 5 mc	0.05 v/cm to 20 v/cm	47 μμf	$175
Type 53/54H DC Coupled High-Gain Wide-Band	0.023 μsec	0.037 μsec	0.07 μsec	dc to 15 mc	dc to 9.5 mc	dc to 5 mc	0.005 v/cm to 20 v/cm	47 μμf	$175
Type 53/54K Fast-Rise DC	0.012 μsec	0.031 μsec	0.07 μsec	dc to 30 mc	dc to 11 mc	dc to 5 mc	0.05 v/cm to 20 v/cm	20 μμf	$125
Type 53/54L Fast-Rise High-Gain	0.015 μsec	0.035 μsec	0.07 μsec	3 c to 24 mc	3 c to 10 mc	3 c to 5 mc	5 mv/cm to 2 v/cm	20 μμf	$185
	0.012 μsec	0.031 μsec	0.07 μsec	dc or 3 c to 30 mc	dc or 3 c to 11 mc	dc or 3 c to 5 mc	0.05 v/cm to 20 v/cm		

Tektronix, Inc.

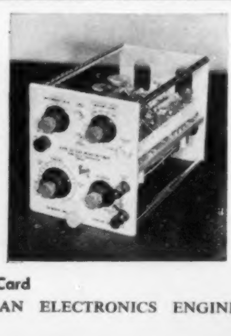
P. O. Box 831 • Portland 7, Oregon
Phone CYpress 2-2611 • TWX-PD 311
Cable: TEKTRONIX

Canadian Field Office

3 Finch Avenue, East
WILLOWDALE, ONTARIO
Phone: Toronto, BAldwin 5-1138

Type 53/54T Time-Base Plug-In Unit

The Type 53/54T generates sweep voltages to drive the horizontal-deflection system of the Type 536 Oscilloscope. 22 calibrated sweep rates from 0.2 μsec/div to 2 sec/div are selected with a single control. 5x magnifier increases calibrated sweep rate to 0.04 μsec/div. Triggering is fully automatic or manual with amplitude-level selection and preset or manual stability control. Unblanking is dc-coupled. Price—$225.



Type 53/54R Transistor Testing Plug-In Unit

The Type 53/54R Plug-In Unit contains a signal source and collector and bias supplies for accurately measuring delay, rise, storage, and fall times of transistors. A mercury switch operating at a repetition rate of 120 c/sec supplies the testing signal. Like all other Type 53/54 Plug-In Units, the Type 53/54R is interchangeable among all Tektronix Oscilloscopes with the plug-in feature. Scheduled for regular production in April, 1958.

Circle No. 26 on Reader Service Card

CANADIAN ELECTRONICS ENGINEERING

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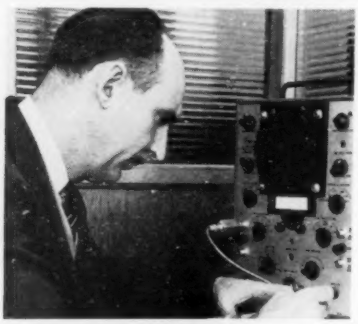
contributors and special articles in this issue:

One of the men behind the new cathode ray oscilloscope, produced by Bach-Simpson in London, Ontario, is author **R. Wilton** (New Canadian CRO has unique features).

Born in 1918 he was educated in Alberta and British Columbia and has been engaged in radio and electronic activities since 1937. He joined the Forces in 1940, retired in 1946 with the rank of Flight-Lieutenant. He had a tour of duty overseas with the RAF and was later in charge of pulse and centimetre training, Clinton Radar School.

He was co-founder of Bach-Simpson Ltd. in 1946 and of Welwyn Canada Ltd. in 1953. He is vice-president and technical director of both companies.



Wilton

Since he joined the Bell Telephone Co. of Canada in 1922 **S. Bonneville** (Radio plays big part in Canada's expanding telephone network) has seen tremendous growth and changes in the Canadian telephone system. He has been associated with all phases of telephone transmission.

From 1927-35 he carried out the fundamental engineering required for the Trans-Canada system. In 1947 he was assigned to radio work and is now staff engineer—radio.

Mr. Bonneville is a member of the Professional Engineers of Quebec and is a senior member of the IRE. He is on a number of committees of the Canadian Standards Association and the Canadian Radio Technical Planning Board, serving as chairman on some of these committees. He is also chairman of the Radio Committee of the Telephone Association of Canada.

Walter S. Kozak, (New job for an old method) joined the Canadian Westinghouse Company's Electronics Division in 1955 as systems engineer. Prior to this he did electronic systems engineering for both the Royal Canadian Navy and the Royal Canadian Air Force in Ottawa. In 1956, he was given the job of installing the company's analog computer and supervising its operation. A University of Toronto graduate, he has done graduate work in microwave communications

Bonneville

Kozak

and advanced servo theory at McGill and the University of Toronto.

L. F. Bennett (Video tape withstands tremendous heat, pressure and abrasion) is assistant division head, Approvals Division of the Canadian Military Electronics Standards Agency in Ottawa. He came to Canada in 1948 from England.

Between 1947-48 he installed the RCMP communication system in Quebec, obtained the Canadian Ministry of Transport Radio Operators license and was chief instructor to the AC-W group at Sherbrooke. In 1953 he wrote the magnetic recording tape specification for the Canadian Armed Services. He is a member of the Radio Society of Great Britain and of the IRE.

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News highlights...

Giants battle over stereo disc recording . . .

Who will win the technical battle for stereo discs? British method records hill and dale and lateral, with one play-back stylus; Americans record either side of the groove and use two play-back styli. Discussions between Decca, EMI and Western Electrical might settle the issue before discs reach the consumer.

More activity in commercial electronics . . .

P. J. Casella, president RCA Victor Co. Ltd., Montreal, expects increased activity in the commercial use of electronics equipment. Reason? Tight money policy, which slowed down capital goods outlays in recent years, has been reversed.

U. S. electronics may reach $14 billion . . .

Forecasters say this year turnover of the electronics industry in the U.S. will be up 5% to a $14 billion total with $9 billion for delivered goods, rest in repairs, service, installation. Over-all U.S. industrial production index fell 6% in the latter part of 1957.

Canada watches soaring missile costs . . .

Major missile problem to Canada is cost. Some U.S. figures for electronics costs: Sidewinder, $4,400; Sparrow III, $40,000; Nike-Ajax, $80,000-$100,000; Snark, $1,000,000. Development and experimental copies of Atlas, Titan, Thor, Jupiter and Polaris are costing around $4,000,000,000.

Vast expansion of education in the U.S.S.R. . . .

Rare public speech by U.S.S.R. Ambassador in Canada, D. S. Chuvahin, gave these facts on his country's expansion in education: pre-revolutionary Russia 127,000 students in higher education, today 2,000,000. Each year 2.5 times more engineers graduate than in U.S., ten times more than in Britain.

Big scope for satellite TV stations . . .

Manufacturers are pushing the idea of satellite TV stations in Canada, suggesting groups of stations might get together to meet capital cost. TV now gets into two-thirds of Canadian wired homes; lack of facilities may account for 20% of blank spots.

RETMA: New committee on communications . . .

The Electronics division of RETMA has formed a General Communications Committee. Its first job is to study DOT 122 specification for a-m single sideband radio telephone equipment operating in the 1.6 to 30 mc. band.

Other committee meetings: Mobile Equipment Engineering, and the Receiver Engineering Committee who discussed a sub-committee report on Safety and the CSA and another report on spurious radiation.

Between January 22-24 EIA in the States held a conference on automation systems as applied to business and industry. Included was a panel discussion on "The economic, educational and social aspects of automation."

Canadian Radio Technical Planning Board's Fixed, Land and Maritime Mobile committee plan preparation of specifications covering motorcycle equipment.

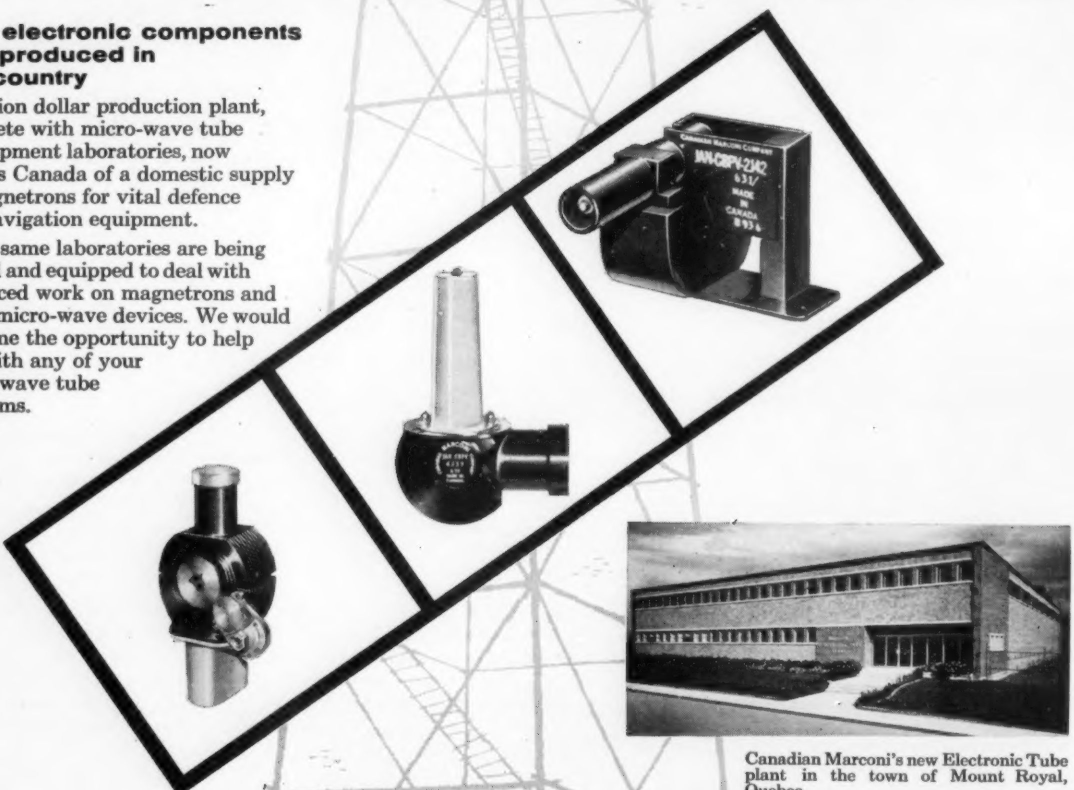
MAGNETRONS

FROM CANADIAN MARCONI

Vital electronic components now produced in this country

A million dollar production plant, complete with micro-wave tube development laboratories, now assures Canada of a domestic supply of magnetrons for vital defence and navigation equipment.

These same laboratories are being staffed and equipped to deal with advanced work on magnetrons and other micro-wave devices. We would welcome the opportunity to help you with any of your micro-wave tube problems.



Canadian Marconi's new Electronic Tube plant in the town of Mount Royal, Quebec.

Electronic Tube and Components Division

CANADIAN Marconi COMPANY

830 Bayview Avenue, Toronto, Ontario

BRANCHES: Vancouver • Winnipeg • Montreal • Halifax • St John's, Nfld.

Circle No. 19 on Reader Service Card

People in the industry

K. R. Patrick leaves CAE — will conduct electronics survey

K. R. Patrick resigned his position as president of Canadian Aviation Electronics Ltd. to devote full time to his campaign for greater emphasis on electronics in Canadian defense and economics.

Mr. Patrick formed CAE eleven years ago and built it into one of Canada's biggest electronics firms. Control is with the North American Management Corporation. He will sell his interest but remain a director and consultant of CAE.

Mr. Patrick told CEE: "My own interest is in analysing the fundamental role of electronics in the Canadian economic scene. I've been talking about it for 18 years and my studies will prove if I'm right or wrong. I believe that in electronics Canada is many years behind and I hope to convince the right people of what can and should be done.

"For the first time in years I can now sit down and work on my theories."

Northern Electric appoints marketing manager

New marketing manager of the sales division of Northern Electric Co. Ltd. is **H. C. Way.** His former position as manager of the company's Pacific Zone has been filled by **J. E. Milburn** with **A. J. K. Griffiths** as the assistant manager.

Born in St. Catharines, Ont., Mr. Way joined the company in 1930, in Toronto. He is a graduate of the management training course at the University of Western Ontario. Mr. Milburn was born and educated in Vancouver and is a graduate of the University of British Columbia. He has been manager of the Edmonton branch, manager of the central district, and marketing manager for the sales division. A. J. K. Griffiths came from Newport, Wales, to join the company in 1920. Since that time he has seen service in Vancouver and has also been sales manager of the electronics division, central district sales manager, and Pacific district sales manager.

Milburn

Way

Marconi creates new division

The Commercial Products and Marine Divisions of Canadian Marconi Company have been merged into the Engineering Products Division with **F. T. Winter** and **R. E. Foreman** as manager and assistant manager respectively.

Also newly created is the position of Manager of Technical and Commercial Development, held by **C. P. McNamara.** Prior to this, Mr. McNamara was manager of the Commercial Products Division with Mr. Winter as the assistant manager.

Ontario engineers elect Carson 1958 president

Charles Terry Carson of Windsor, Ont., has been elected president of the Association of Professional Engineers of Ontario for 1958. In business life, Mr. Carson is vice-president and production manager, Hiram Walker & Sons Ltd. He is also chairman of the committee on engineering education at Assumption University, Windsor.

Born in Oakville, Ont., Mr. Carson moved to Alberta at an early age and received his school training there. He returned to the east with his family shortly before enlisting in the 40th Battery in the First World War.

In 1923 he graduated from the University of Toronto in chemical engineering and held a number of positions with various firms before joining Hiram Walkers in 1944.

Last year, Mr. Carson was the Association's 1st vice-president. This position for 1958 will be held by **Andrew F. McQueen,** president of H. G. Acres & Co. Ltd., Niagara Falls.

Three appointments at Robertshaw-Fulton

F. H. Barker has been appointed general sales manager of Robertshaw-Fulton Controls (Canada) Ltd. With the company since its inception in 1954, he has served earlier as production manager, then plant manager.

G. H. Warren has succeeded Mr. Barker as plant manager. Formerly with the experimental department of Courtaulds of England, Mr. Warren joined Robertshaw-Fulton in 1955 as production manager.

P. S. Barkhouse, formerly working in the service department and laboratory, takes over the duties of field service manager.

Barker

Barkhouse

Research engineer heads up Collins Radio of Canada

J. P. Giacoletto has been appointed general manager of Collins Radio of Canada Ltd. He has held the position of director of engineering since the company started engineering and manufacturing operations in Toronto in 1955.

A graduate of The Rose Polytechnic Institute of Terre Haute, Indiana, Mr. Giacoletto joined the Collins Radio Co., Iowa, in 1935. Development work has been his specialty and he was head of Dept. IV of the Research and Development Division at Cedar Rapids prior to coming to Canada. He is a senior member of the I.R.E.

Giacoletto

Abe Pelt of Cesco dies in Montreal

The Montreal Industrial Representative of Canadian Electrical Supply Co. Ltd., **Mr. Abe Pelt,** died recently. He was 49 years old at the time of his death and had been with Cesco for the past 20 years.

Simpson STANDARD PANEL INSTRUMENTS

Canadians like Canadian-made Instruments — but even more — they like a prompt and direct engineering service on their peculiar instrument problems.

Bach-Simpson engineer *completely* every instrument produced in Canada and can offer detailed and comprehensive engineering advice to meet any application problem you might have — all based on 15 years experience in Canada.

As a Canadian owned Company — our manufacture is complete from movement design, tool and mold manufacture, through case styling, dial printing to packaging — all in either commercial or military types.

Apart from the complete coverage of all electrical types and ranges — over 50 different case styles alone are available from Canadian production and tooling — and if you find your application calls for a new design — our engineering department is at your disposal.

Bach-Simpson Limited also produce Laboratory Test Apparatus, Radio Service Equipment, Automotive Service Test Equipment, Electronic Control Apparatus for Industry and Instrument components and accessories.

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Circle No. 15 on Reader Service Card

New president moves in as Philips reorganize Canadian set-up

The Philips group has reorganized its Canadian operations into one company, Philips Electronics Industries Ltd. The new firm, formerly Canadian Radio Manufacturing Co., will operate in three divisions—Philips Industries Ltd., selling radios, television sets, lighting and hi-fi equipment, tape recorders and electric shavers; Rogers Electronic Tubes and Components, marketing tubes and parts; Industrial and Medical Equipment Divisions, selling specialized equipment including aviation gear.

D. C. F. van Eedenburg has been appointed president of Philips Electronics. He joined the Philips organization in Britain in 1935 and until last year managed Philips operations in the Philippines.

President and managing director of TMC (Canada) Ltd., D. V. Carroll (left) with E. Givens, CAA, examine the transmit-receive equipment for Afghanistan.

Firm will manufacture laminated phenolic

The Spaulding Fibre Co. of Canada Ltd., formed at the beginning of the year, announces that a plant will be established in the Toronto-Hamilton area within three months and will fabricate and stock laminated phenolic, vulcanized fibre, transformer pressboard and Spauldo (rag paper).

A branch sales office has been in operation at 106 Lakeshore Road East, Port Credit, Ontario, for over a year.

Direct link for TCA over Atlantic

TCA President Gordon McGregor has announced that his company is operating the first airline teletype circuit over the North Atlantic's new telephone cable.

Using the new tripartite cable operated jointly by Canada, the U. S. and Britain, TCA's privately leased channel will result in instantaneous communication between Montreal and London airports. The bulk of airline communication between these two centres is presently routed via New York and Paris, and is sometimes adversely affected by atmospherics.

Canadian equipment for Afghanistan

TMC (Canada) Limited, who make communications equipment, have recently completed the design and engineering of a radio communications system for export to Afghanistan.

The project is under the auspices of the International Co-operation Administration and Civil Aeronautics Administration of the U.S. Department of Commerce in Washington.

The equipment consists of radio transmitting, receiving and remote control units and is designed for installation in a number of airports in Afghanistan to provide up-to-date radio communications. This equipment is being purchased as part of a world-wide program for airport modernization.

Mobile radio order goes to CGE

Royce plant of the Canadian General Electric Company in Toronto is busy on a City of Toronto contract for 79 mobile units, four remote-control units, one main station and a 5-year maintenance contract; total cost $100,000.

This complete communications system will be shared by five departments: Works, Traffic, Street Cleaning, Parks and Recreation and Property.

Another order being handled by the same plant is for seven special main stations and three mobile units for Metropolitan Toronto Civil Defense.

New devices in solid state field

A team of French scientists working at the Postal, Telegraph and Telephone Administration's national centre for the study of telecommunications in Paris have announced a new solid state device, the tecnetron.

The device can operate at frequencies from 400 to 1,000 mc and should eventually be capable of handling several watts.

The tecnetron is composed of germanium, the metal indium and has three electrodes. It is two millimetres long with a diameter of 0.5 millimetres.

Radio sales still going up

RETMA figures for November show that radio, record player sales continued to rise. Total figure for the year to that date is 515,724 against 506,578 for the same period in 1956.

Substantial rises come in the portable class with 50,166 for the 11 months compared with 39,591 of the previous year and in the combination sets, particularly consoles over $200, with a total of 48,686 against 36,952. Total record player sales were 112,215.

For the same 11 month period television sales dropped from 561,590 in 1956 to 426,356. All figures are distributor sales to dealers.

Aviation Electric add floor space

Aviation Electric Ltd. have added 35,000 sq. ft. to their Montreal plant. The new area houses an air-conditioned manufacturing machine shop and special test facilities for jet fuel controls, fuel flowmeters and hydraulic and other equipment associated with highly inflammable liquids.

News in brief

Electrical Products Mfg. Co. Ltd., of Mt. Royal, Que., are licensed to manufacture Dumont Television, phonographs and radios in Canada. The firm at present makes Fleetwood sets.

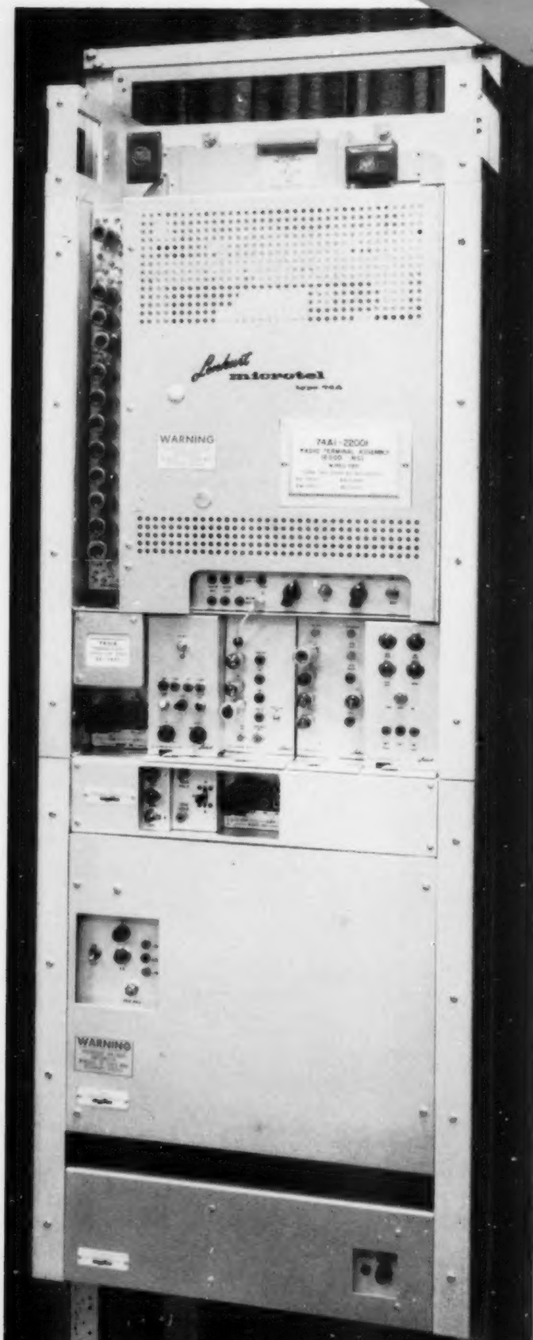
Charles L. Thompson Ltd., 3093 Woodbine Drive N., Vancouver, B.C., are now exclusive sales representatives for David Bogen Co. and Presto Recording Corp., in the western half of Canada, including Manitoba, Saskatchewan, Alberta and British Columbia.

MEL Sales, Arnprior, Ontario, have been appointed representatives of Weldmatic Division of Unitek Corp., Pasadena, Calif., and of the Arnoux Corp., Los Angeles, Calif.

Spectrol Potentiometers, San Gabriel, Calif., are now represented in Canada by E. E. Whittaker, P.O. Box 3255, Arnprior, Ontario.

Lenkurt

microtel



NEW microwave equipment for the 6000 mc. band.

Microtel is *new* . . . the most advanced microwave radio equipment on the market. Designed for high quality transmission of telephone, telegraph, telemetering, and other types of information, it can be equipped to operate throughout the range 5925 to 8500 megacycles.

Microtel is equally satisfactory whether the need is for only a few circuits or for a high density network requiring as many as 720 voice channels. It is available from Automatic Electric as a complete package—engineered, supplied and installed—on one order.

FEATURES

- **POWER OPTIONS**—Operates from standard office battery supplies or from 115-volt a-c mains.
- **LOW POWER CONSUMPTION**—Unique design permits economical office battery operation.
- **EASE OF INSTALLATION**—Standard 19-inch rack mounting; compact plug-in construction; space-saving—no rear access required.
- **EASE OF MAINTENANCE**—Components accessible from front; built-in test facilities fully alarmed.
- **STABLE OPERATION**—Use of reference cavity and heat sinks eliminates conventional ovens and blowers.
- **ECONOMICAL EXPANSION**—With Lenkurt 45BX carrier, a single terminal can accommodate up to 240 channels; with r-f circulator, 2, 3 or 4 terminals can be added to same antenna system.
- **REPEATERS**—Back-to-back terminal equipment permits dropping and reinserting of channel groups; automatic switching permits unattended operation.

For complete information write or call your nearest Automatic Electric office.

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AUTOMATIC ELECTRIC

ORIGINATORS OF THE DIAL TELEPHONE

GENERAL SYSTEM

Circle No. 12 on Reader Service Card

R & D—the key to electronics prosperity

Intensification of research and development activity must be the cornerstone of a solid future for the Canadian electronics industry.

This point came up time and again as we talked to executives in preparation for our Industry Review and Forecast feature. Mr. W. H. Jeffery, President of RETMA, suggested that although Canada's relative economic smallness reduced our competitive prospects in the mass-production of many items, R & D were fields in which this country could make a significant contribution.

In the area of research, basic and applied, activity to date has largely been concentrated in the Defence Research Board, the National Research Council, Atomic Energy of Canada Limited and the universities.

Very few industrial concerns have set up any kind of research organization. Some spokesmen have suggested that more firms would have done so had there been more evidence that the Government were prepared to award research and study contracts, rather than build up the establishments mentioned above.

We believe that this attitude tends to confuse the positions of the cart and the horse. It seems only fair that a company should show evidence of the availability of suitable scientific brainpower and facilities—at least at a basic minimum level—before it can expect to be entrusted with projects involving the expenditure of public funds.

One company in Montreal has proved the validity of this approach. Having established the capabilities of the research team which it has gathered together, it is now being awarded study contracts on an increasing scale.

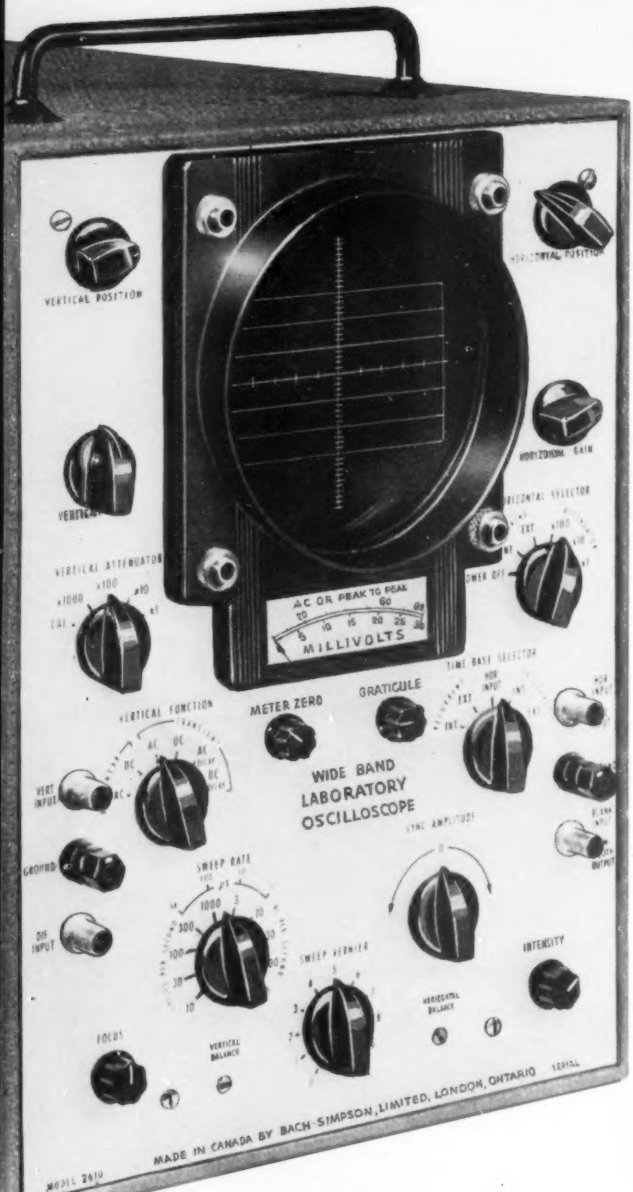
The establishment of a research facility does, however, require funds which, in most cases, can only come from profits on the sale of items acceptable to either the consumer or industrial markets. It is also valid to assume that the amount of defense research work to be done in Canada will bear some relationship to Canada's eventual role as a defense producer. But even though the projects undertaken at first may not be directly related to the company's end products, other benefits may soon be apparent.

The company referred to above, for example, has found that transferring small groups of engineers from its design departments to short term assignments in the research laboratory has worked out extremely well. Not only has the laboratory been provided with manpower who have made a significant contribution to its total achievement, but the engineers have returned to their normal duties with a broadened scientific perspective.

Canada already has several scientific "firsts" to her credit as a result of work done in the past. Let us hope there will be many more as industry and government work hand-in-hand to make the most of our country's unique position.

THE EDITOR

New Canadian CRO has unique features



R. WILTON, SEN.MEM.I.R.E.*

A medium priced cathode ray oscilloscope has been completely developed, designed and produced in Canada. The new instrument is capable of performing almost all the operations for which much higher priced laboratory 'scopes are normally used. Circuits include a slide-back amplitude measurement system with a built-in meter and a novel calibration arrangement

It has long been the opinion of the author that between the very finest oscilloscopes now on the market and the much lower priced service type of equipment, there exists a rather awkward gap. Thus, in most laboratories, research institutions and colleges, the "Cadillac" type, because of its overwhelming advantages in ease of operation, stability and performance, is much in demand—often on relatively simple jobs not in the least demanding of such a beautiful instrument—while the cheaper service equipment languishes on the stockroom shelf.

There seems to be a real need therefore, for a quality oscilloscope in the medium price range; a 'scope which, because it will perform 95% of the operations normally assigned to the more glamorous competition—but at approximately half the price—should make a welcome addi-

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*Bach-Simpson Limited, London, Ontario.

tion to any laboratory. These were the objectives targeted during the course of development of the Model 2610, and the extent to which these objectives have been met will no doubt be indicated by the degree of acceptance or otherwise of the instrument in the months ahead.

Y-axis amplifier

A 5ABPI type cathode ray tube is employed, operating with a total eht of approximately 2,300 volts. To realize the deflection sensitivity, gain and bandwidth desired under such operating conditions, a three stage amplifier was required; and since it was highly desirable that it be direct coupled, considerable problems in long term drift stability were encountered. These have been reduced to a minimum by extensive precautions, as follows:

(a) The amplifier is operating in push-pull or balanced condition throughout. Thus, any in-phase drift components appearing at the deflection plates cancel out: only differential signals anode-to-anode produce deflection.

(b) Both the low and intermediate plate voltage power supplies are regulated.

(c) The preamplifier filaments operate on regulated dc. In any direct coupled amplifier a major source of drift arises in the input stage due to filament voltage changes. Even though grid and cathode potentials remain constant, plate current will vary in sympathy with cathode temperature changes. As noted in (a) above, the effect of this can be reduced by balanced operation. A further improvement is produced by filament voltage regulation.

(d) High stability components—notably load resistors —are used throughout. Temperature coefficients of these have been carefully engineered so as to minimize differential drift where this might be a problem.

Thus, freedom from drift is unusually good, even when the high gain (up to 2,500 x) and/or high deflection sensitivity (2.5 millivolts rms/cm) are considered.

To be a truly useful tool, the cro should be capable of accurate amplitude and time measurements, as well as faithful portraying the wave shape of the phenomenon under observation. In the Y-axis, this involves constant gain over a specified bandwidth, accurate amplifier calibration and a suitable method of interpreting amplitude response has been achieved from dc to 6 mc minimum in absolute units. Thus, for sine wave observation, linear response has been achieved from dc to 6 mc minimum with an over-all accuracy of ±3%. This has been accomplished by "propping up" the response with bandpass filters—with a rather sharp cut off taking place above this figure. Since this is unsuitable for pulse waveforms, a modified response can be switched in giving a roll off, which is the best compromise between rise time and overshoot. In this position, the rise time is approximately 75 millimicroseconds, while the overshoot is in the order of 2%.

A built in matched delay line may also be switched in for viewing fast rising transients when the time base is operated in the triggered mode. This is dealt with later, under the sweep circuit heading.

Unique calibrating method

Many oscilloscopes feature amplifiers which are precalibrated and/or methods by which the calibration may be recertified at any time. Even so, with time the gain of even the best of the former will drop off, while in others the calibration signal may in itself be suspect with fairly extensive errors resulting. To avoid these complaints, a unique calibrating method is employed in the Model 2610 and by its use, the instrument may be calibrated to

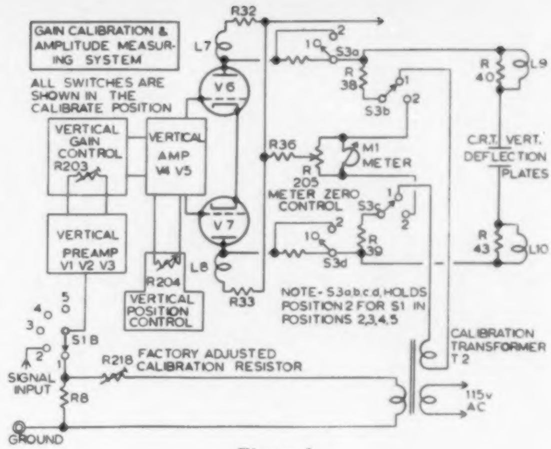


Figure 1

the original factory set accuracy in less than five seconds.

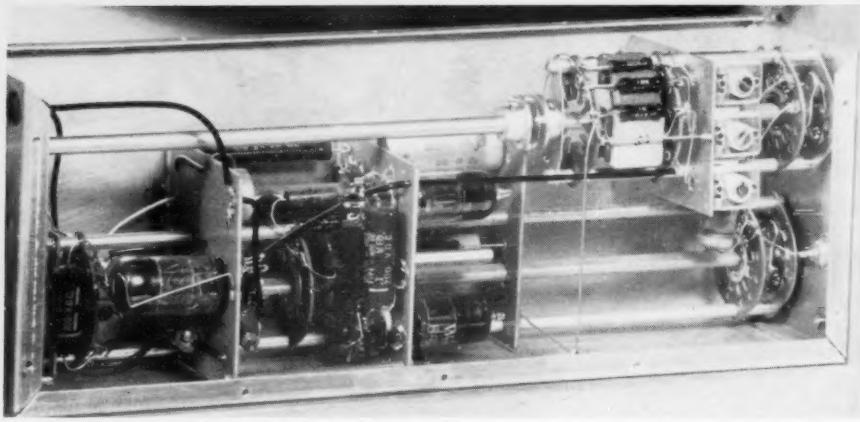
A simplified diagram of the gain calibration and amplitude measuring system is illustrated in fig. 1. Operation is as follows:

The calibrating net work employs two signals in fixed amplitude ratio delivered from windings on a common transformer operating at line frequency. The ratio of these signals is adjusted at the factory to equal the gain factor required of the amplifier in the calibrated position. Thus, when the smaller of the signals is applied to the amplifier input, only one setting of the gain control will produce an amplitude equal to that of the larger signal bridged directly into the comparator circuit at the output of the same amplifier. To make comparison easy, the phasing of the two signals is such that complete cancellation takes place for signals of equal amplitude and thus the display goes through zero when the gain of the amplifier is correctly set. Since the ratio of two signals is constant regardless of line fluctuations, and since crt is used only as a null indicator, virtually no errors can result. The utter simplicity of this method, coupled with the extreme accuracy, permits practical use of the instrument either uncalibrated and at maximum sensitivity, or calibrated at a fixed lower gain, as desired.

Amplitude measurement

If reasonably precise measurements are to be made when displays are scaled directly against a graticule on any cro, the vertical deflection factor of the over-all system, once calibrated, must remain constant. This involves not only the gain of the amplifier, but the deflection sensitivity of the crt as well. Maintaining reasonably constant crt deflection sensitivity involves eht regulation and, to avoid this expense and complication, the slide back system has been employed, thus obviating the requirement that the deflection remain constant. Actual measurements are obtained by displacing the waveform through its own amplitude on the crt with a built-in meter reading the shift voltage required to accomplish this. The meter is scaled in both rms and dc, and it will be apparent that, with such an arrangement, changes in deflection sensitivity during or after the measurement will have no effect on accuracy: such changes act on both shift and signal voltages equally. A meter biasing control is employed so that readings may always be referred to zero on the meter scale and a conventionally illuminated graticule is also provided for those applications where the greater accuracy of the slide back system is not required.

In assessing the final read out accuracy of the complete system, it is necessary that all possible cumulative errors



"Y" axis attenuator, preamplifier and cathode follower compartment.

be considered. These will include variations in attenuator ratio and amplifier response throughout the bandpass, meter sensitivity and tracking problems, accuracy of amplifier calibration and so on. The advantages of having manufacturing facilities for both resistors and meters on the premises are apparent here and, by proper co-ordination of component and circuit design, it is possible to claim an over-all accuracy of 5% or better for all amplitude measurements.

As an example of the above, it is worth mentioning the errors normally associated with standard panel meters of the type employed in this design. Three major factors contribute to the total reading error involved:

(a) The percentage departure from rated full scale sensitivity.

(b) The tracking error exhibited by the meter across the scale arc, and

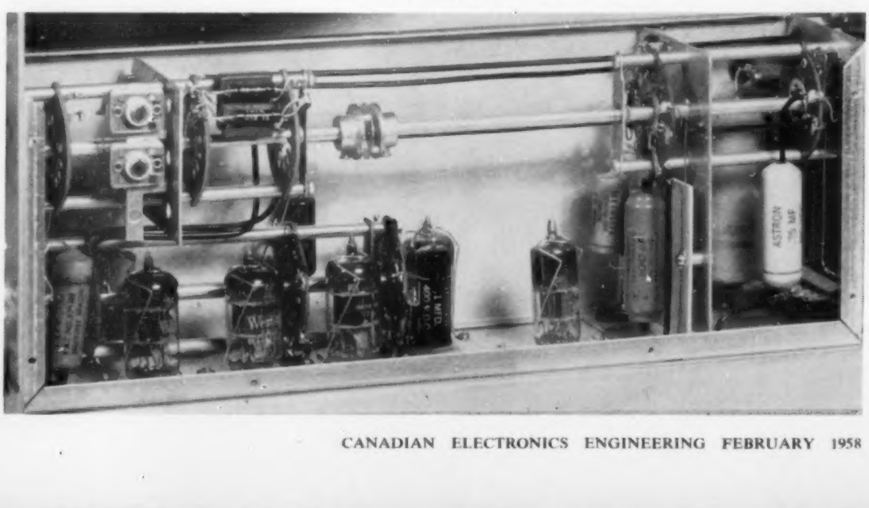
(c) The effect of friction, which becomes increasingly large at readings approaching zero deflection.

(a) In this instance, because of the method employed in calibrating the over-all system, of which the meter is only one component part, variations in basic meter sensitivity from one unit to the next are completely absorbed.

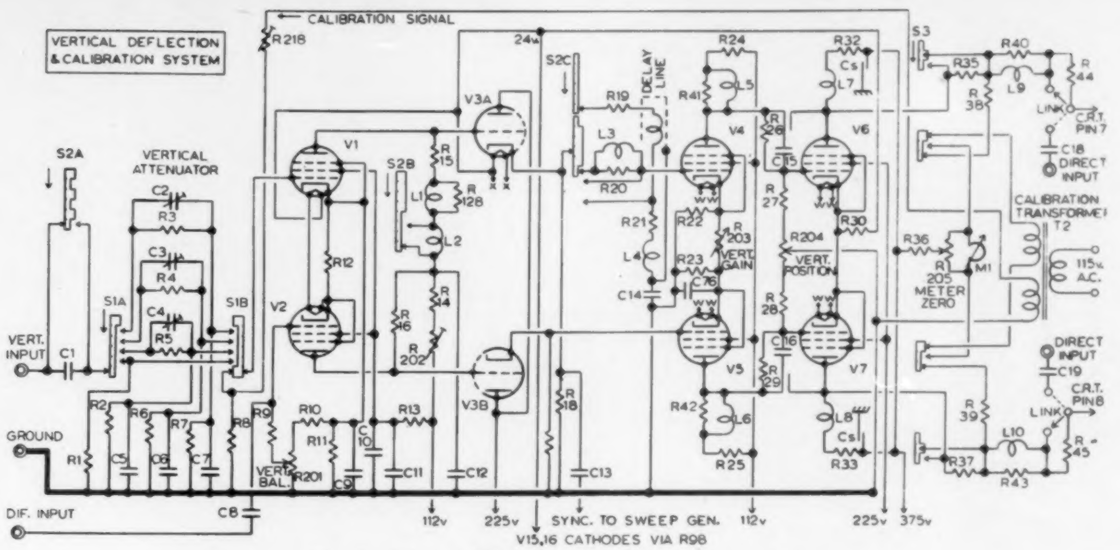
(b) Tracking error in D'Arsonval instruments is largely a function of nonlinear flux density in the gap; in such meters, the problems increase with arc length so that not only will the scale calibration depart from strictly geometric graduation, but variations from instrument to instrument will be more pronounced. It has become customary on miniature panel instruments to employ 100 deg. arcs as a compromise between scale length and tracking errors. However, in this application, it was possible to take advantage of the extra space available behind the panel and a special meter was developed having a long pointer and a 60-deg. arc. This treatment produced a scale approximately equal in length to that of a standard 4-in. meter. However, the reduction in deflection angle results in a virtual geometric scale so that tracking errors normally associated with printed scales become practically non-existent in this design.

(c) Normally friction error is most apparent for small deflections about zero on the scale. Thus, at say 10% deflection, even the best instruments can easily exhibit an error of 10% or more in terms of the reading at that point. This may be acceptable in most applications but would be intolerable in this instance. Here again however, by co-ordinated design, it has been possible to reduce this effect to acceptable limits by manufacturing the instrument as the centre zero type, i.e., when no deflection current flows the pointer rests in the mid scale position. The scale however, is calibrated in the conventional manner with the zero at the left of the arc and numerical progression up scale. Thus, with the trace in the centre of the crt and therefore not under the influence of deflecting potentials, the meter reads approximately centre scale.

In measuring the signal, it is displaced downward until its top coincides with a convenient horizontal line on the graticule. This tends to depress the meter reading toward zero **on the scale**—but in so far as the meter itself is concerned—toward an area of maximum torque. Since only by coincidence would the meter reach scale zero with the signal properly referenced to the datum line, meter biasing is employed and by its use, the pointer can be placed on zero for any measurable signal amplitude. It is now apparent that should it be necessary to measure signals of small amplitude, say 10% of full scale as previously noted, the friction effects normally associated with such minor



Sync amplifier, time base and blanking compartment. Also shown is the "X" axis attenuator.



Circuit of the vertical deflection and calibration system

deflections are swamped out by the high torque developed at this point.

It is obvious with this arrangement that frictional effects will be greatest at centre scale. However, it is equally true that these will now be referred to a signal of major proportions and will therefore—in terms of percentage of reading—produce an error of negligible proportions.

Y-axis Output Stage

The 5ABP1 crt is designed to provide full screen deflection in both X and Y-axis. The sensitivity on the Y-axis therefore is much lower than with many of the special crt's currently employed in wide band oscilloscopes where only limited vertical deflection is possible due to the proximity of the deflection plates to the beam and the shadow effect which results. Thus, the design of an output stage having reasonable bandwidth, combining at the same time, an ability to handle large signal voltages with low distortion, becomes a problem of some magnitude.

Extension of the upper frequency limit in the face of a given capacitive loading calls for a reduction in plate load resistance. This of course is diametrically opposite to the requirement for a large undistorted signal output. For obvious reasons, there is a limit to the plate current swing possible or permissible in the output stage. Thus, the final design becomes a compromise between these conflicting factors and, in the 2610, 2.5KΩ plate loads with both series and shunt compensating networks, are employed.

With these values, a full 12 cm's of deflection is possible with less than 3% distortion. Alternatively, 6 cm's are the limit when absolute measurements by the slide back method are required. To achieve this performance great effort was required to reduce stray capacities to the minimum. This in turn was additionally complicated by the requirement that the calibrating switch and associated components should be located in the anode circuits as well as the terminals which provide direct access to the Y plates.

Special 10 watt oxide film anode load resistors were developed having virtually zero capacitive and inductive effects at the frequencies involved, and were designed for end mounting against the chassis. B+ is fed into the chassis and via special large end caps which, in addition to providing an excellent heat sink to the chassis via the mica insulation interposed, produces a highly effective rf bypass of approximately 45 pfd at the point where it is most desirable.

Triggering, Sweep and Blanking Circuits

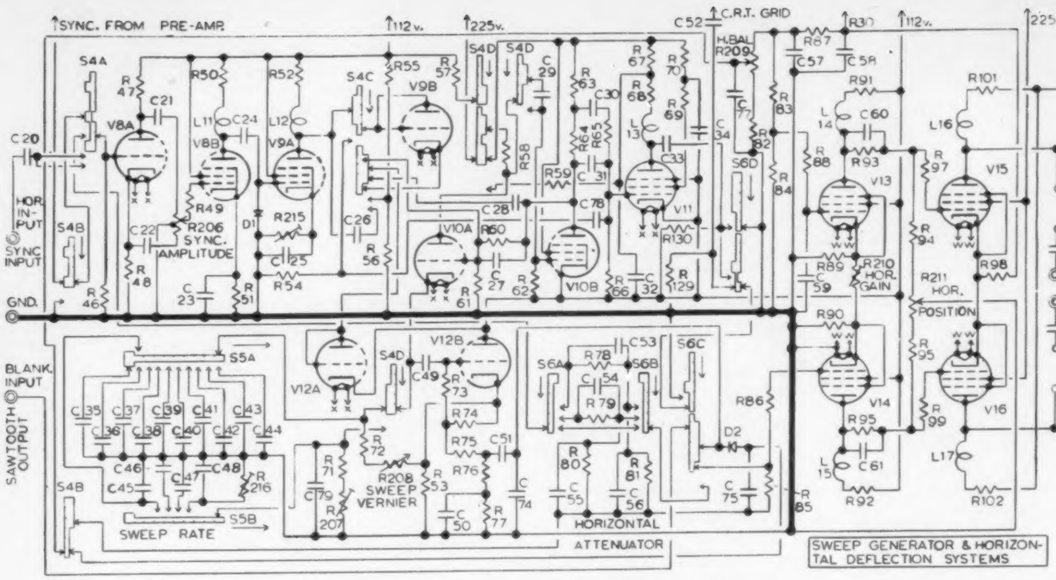
Since triggered as well as free run sweeps have been provided, signal delay in the Y-axis amplifier is necessary. This may be switched in or out as desired and introduces approximately 0.3 microseconds delay to the signal. Located between the preamplifier cathode follower and the main Y-axis amplifier, the delay line is properly matched, eliminating signal circuit loading and permits a rise time compatible with that of the over-all system. The trigger signal take off preceeds the signal delay, feeding a phase splitter and two stage trigger amplifier. This features fast rise time and deliberate overshoot plus limiting, thus permitting the sweep to start with minimum delay. Its gain is such that internal triggering on signals of either polarity is possible for all practical signal amplitudes and/or settings of attenuator-gain controls.

Diode gating and clamping is employed to provide maximum stability in the sweep circuit; thus stable triggered sweeps are produced under the three possible operating conditions where:

(a) The sweep duration exceeds by many times the interval between repetitive pulses and a series of pulses is therefore displayed.
(b) The sweep duration exceeds the pulse width by some factor but does not equal the interval between one pulse and the next.
(c) The pulse duration exceeds the sweep duration; the sweep in this case being obliged to cut off at the precalibrated time interval even though the trigger signal may still be present.

In triggered operation the sweep duration rather than amplitude is a fixed quantity and is controlled by the time constant in the cathode of the modified "flip flop" circuit. The design features a high degree of stability which, coupled with the triggered gate circuit, provides sufficient immunity from external influences so as to permit the cathode to run down at a rate controlled only by the particular C.R. combination in use.

Thus, regardless of the gain (and therefore sweep length) in the X deflection amplifiers, the time represented by one sweep remains constant. In practice, however,



Circuit of the sweep generator and horizontal deflection systems.

the sweep length is generally adjusted to fill the whole 10 cm on the graticule so that precise time intervals are easily determined. Four such precalibrated sweeps are provided having durations of 5,000, 500, 50 and 5 microseconds; a fifth uncalibrated sweep of approximately 1 microsecond is provided on all other positions of the sweep selector switch.

On free run, linearized sweeps from 3 to 500,000 per second are provided and again because of the superior stability of the circuit, synchronizing of sine waves up to 10 mcs per second is easily accomplished. For the same reason, pulses of less than 0.5 microsecond can be viewed at full X-axis expansion without noticeable jitter.

Retrace blanking on free run is effective from the lowest to the highest sweeps involved, this being accomplished by both high and low frequency compensation in the blanking amplifier circuit. On triggered operation, a brilliance pulse is supplied to brighten the trace coincident with the beginning of the sweep. The fast rise time provided by the blanking amplifier is adequate to raise the trace to full brilliance well in advance of the leading edge of the pulse to be displayed.

X-axis Amplifier

This is similar to the Y-axis amplifier in that it operates in balanced, push-pull, direct coupled fashion but employs only two stages and produces lower gain. For this reason, it was unnecessary to employ filament voltage regulation. The bandwidth is adequate to pass the highest sweep frequency (500 kc) without distortion and has a gradually falling characteristic above 1 mc and is down about 3 db at 1.5 mc.

Similar to the Y-axis, the gain is controlled by an attenuator having ten to one steps with a continuously variable gain control providing intermediate coverage. Because of the more limited band pass, larger plate loads are employed. These in turn, permit many times full screen deflection horizontally with minimum distortion factors.

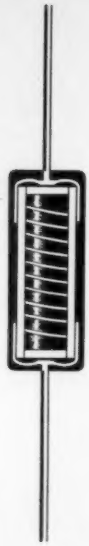
By means of interlocking switching, the input to the amplifier can be brought out to the front panel via the attenuator; when connected internally the attenuator is bypassed and capacitive coupling is provided to the cathode follower sweep circuit output. Because capacitive coupling is involved at this point, it was found desirable that diode clamping be employed at the input to the amplifier grid: this is however, only applied when the sweep is operating in triggered fashion.

Power Supplies and Shielding

The main plate supply employs two indirectly heated rectifier tubes delivering approximately 375 volts of filtered dc which is employed on the anodes of the output stage deflection amplifier. A pair of series regulator tubes operating in parallel provide an intermediate regulated source at 225 volts and a further series regulator tube produces the lowest plate supply voltage source—112 volts. DC for the filaments of the preamplifier tubes is provided by the return of the combined plate and screen currents of the four 6CL6 deflection amplifiers. Considerable regulation of this voltage is provided in that the pentode's plate current, when operated with regulated screen voltage, is almost completely independent of plate voltage variations. For this reason, even larger line voltage variations will have but little effect on the drift characteristics of the over-all Y-axis amplifier.

It became apparent in the very earliest stages of the engineering of the Model 2610 that extreme precautions were needed if the complete flexibility desired was to be obtained without some interaction between the various circuits, which would otherwise result in undesirable pulse distortion. It should be apparent to even the uninitiated that pulses having rise times of 20-40 millimicroseconds are extremely difficult to control and the problem becomes increasingly difficult when switching and common inputs are involved.

For this reason it became necessary to separate the X, Y and Z functions entirely, and, as is often the case in these matters, the resulting layout becomes extremely clean and simple with the shielding—while quite extensive—still lending a clean appearance to the over-all chassis. Inevitably also switching becomes complicated and additional decks and banks of contacts were necessary in order to ensure that, under all conditions of operation provided for, the interactions referred to are kept to the absolute minimum. END



This recently announced component can span the diverse requirements of a computer needing performance for many hours and guided missiles requiring it for only a few minutes. Construction, specifications and performance are all described

The versatile Vamistor

New precision resistor combines best features of wire wound and deposited carbon types

*R. C. LANGFORD

Components engineers charged with the responsibility for specifying precision resistors often have an extremely difficult choice to make. Many otherwise well-informed men assume that when they buy a resistor adjusted to 1/10 of a per cent they are, in fact, buying a unit good to 1/10 of a per cent throughout its working life. Careful examination of the specification reveals permissible changes in resistance of ½% load life, .2% temperature cycling, ½% short time overload, 1% moisture, and ½% salt water immersion, which come as something of a surprise. In substance then, the word "precision" in connection with resistors must be very carefully weighed.

The latest type wire wound resistors currently have a good initial tolerance adjustment, low reproducible temperature coefficient, and good stability and moisture characteristics, but suffer from the disadvantages of poor high-frequency performance (due to inter-layer capacitance) and a possible tendency towards open circuiting when fine wire is used. Certainly in the high resistance ranges the wire wound resistors are bulky as well as of fairly high cost.

Should these detractions prove serious, the components engineer often has to give consideration to the use of deposited carbon resistors, which have the virtues of good high-frequency performance together with small size, low cost, and nonuse of critical materials during a national emergency. However, this type of resistor replaces the advantages of wire wound resistors with rather severe disadvantages including poor stability, poor initial tolerance adjustment, high temperature coefficient, and noise.

Construction of the Vamistor

The Weston Vamistor, now obtainable in four models, has practically eliminated the necessity for compromise on the part of the components engineer, since the unit contains the best features of both wire wound and deposited carbon resistors, while eliminating virtually all of the disadvantages of both types. The unit has the conventional external appearance of a deposited carbon type resistor and the performance of the metal film type of unit.

The sectional view shows the Vamistor having a cylindrical ceramic tube with a conducting band of silver fired on each end. These bands extend over the annular end surfaces and 1/16 in. along the length of the inside and outside surfaces and have an extremely tenacious bond to the ceramic cylinder. The internal surface of the cylinder is prepared with a high-temperature fired glaze coating and the resistive metal film proper is thermally fused onto the internal surface between the conducting silver bands. This metal resistive film is obtained from a highly refined and carefully controlled alloy of the nickel-chrome family very closely related to the wire now used on the better precision wire wound resistors. After deposition of this alloy film a firing treatment is given to disperse the film throughout the body of the glaze. Adjustment of resistance of this dispersed alloy is made in the conventional manner by cutting a groove in the form of an internal helix until the desired value of resistance is obtained. End caps and leads are then pressed over the ends of the cylindrical tube and the whole assembly is molded into an epoxy resin shell.

This encapsulation is, of course, designed to secure the advantages of an insulated resistor good for the usual V-block test of 900 V rms for one minute. Additionally, however, the unit is converted into a form virtually impervious to weather, humidity, and salt spray conditions. This internal type of construction requires a greater space than would be needed if the metal precision alloy were on the outside of the cylinder. In spite of this and the other difficulties of adjusting the resistance value inside a small tube, the internal construction does not require that any paint, lacquer, or encapsulating materials be in contact with the metal alloy. This fact is known to have very considerable bearing on the excellent performance characteristics of the Vamistor.

Although the nickel-chrome alloy used is of the same family as that used for wire wound resistors, the bulk requirement of material is a great deal less, many tens of thousands of Vamistors being made from one pound of alloy material. This fact, of course, has considerable importance in times of critical procurement.

It should be borne in mind that continuous improvement has been made on the Vamistor in the relatively short time it has been in production. The emphasis

*Weston Electrical Instrument Corp., Newark, N.J.

Derating curves

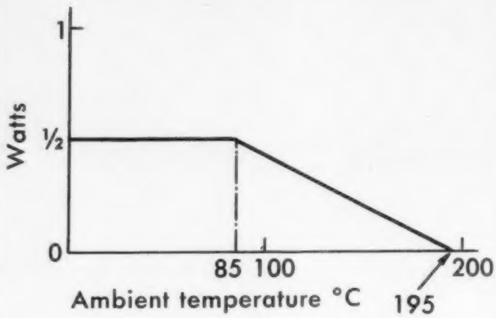


Fig. 1. Model 9851

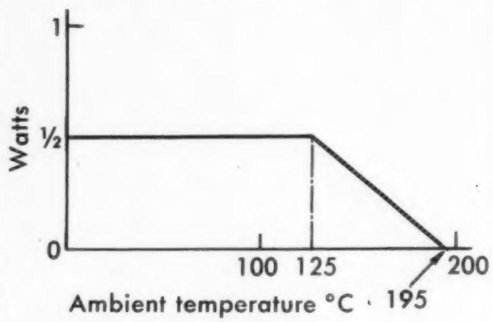


Fig. 2. Model 9852

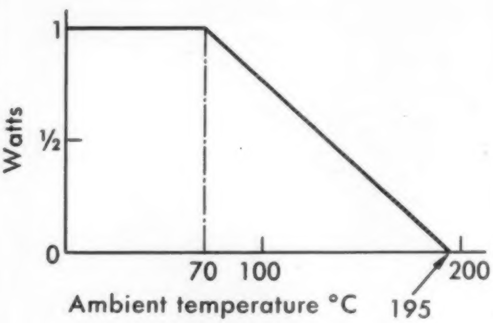


Fig. 3. Model 9853

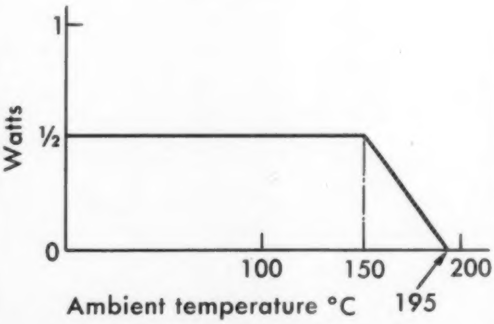


Fig. 4. Model 9854

throughout has been on achieving high performance, but many of these improvements have been accompanied by considerable reduction in cost, and while the initial mass production technique is dedicated to the production of accurate, reliable units together with elimination of unsatisfactory parts, the final cost when in full volume production will rival that of the present deposited carbon resistors. The Vamistor has now been approved under the MIL-R-19074A specification for precision metal alloy resistors, which is perhaps the most stringent existing specification for a precision resistor.

Specifications and Performance

The specification for the Weston Vamistor is listed in tabular form in Table 1 and the more important items will be commented on in sequence.

TABLE 1
SPECIFICATION FOR WESTON VAMISTOR

Characteristic	Test	Requirement
Resistance	Minimum (ohms) Maximum (megohms)	250 1
Power rating	Model 9851 Model 9852 Model 9853 Model 9854	½ watt 85°C ½ watt 125°C 1 watt 70°C ½ watt 150°C
Accuracy		½ or 1%
Temperature Coefficient	p.p.m./°C	±50 max. ±25 max. (selected)
Short time overload	5 times – 5 sec.	½% max.
Load life	1000 hrs. at elevated ambient (85, 125 or 70)	½% max.
Temperature cycle	5 cycles –55°C to +85°C	.2% max.
Low temperature	24 hrs at –65°C	½% max.
Applied voltage	Volts	500 max.
Moisture resistance	Method 106 MIL-STD-202	½% max.
Salt water immersion	5 cycles 0°C to +85°C	½% max.
Solder	3 sec. 350°C solder	.2% max.
Insulation resistance	100 volts D.C. V Block	1000 megohms min.
Dielectric strength	1 min. 900 volts R.M.S. V Block	.05% max.
Terminal strength	5 lb. pull	.2% max.
Size	Body length (in.) Body dia. (in.)	¾ ± ⅛ 5/16 ± 1/32
Voltage Coefficient	p.p.m./volt	5

a. Resistance: The resistance ranges possible vary from 250 ohms to 1 megohm. This subject, however, is very closely related to that of temperature coefficient. The over-all temperature coefficient of the unit is the net sum of the positive temperature coefficient of the alloy used and the negative temperature coefficient due to the expansion stress in the film and glazed layers. Thus, low resistance units tend to have a high positive temperature coefficient and high resistance units tend to have a high negative temperature coefficient (due to the paucity of alloy used and hence the dominance of the stress effect). MIL-R-19074A specifies a requirement of ±50 parts per million per degree C and this is the limiting factor at the present moment which restricts the range from 250 ohms to 1 megohm. Units can be made down to about 10 ohms with temperature coefficients of the order of 200 parts per million. These limits, it should be noted, are not seen as impregnable barriers. Rather, they are limits which can be pushed back steadily as commercial conditions justify the research and development necessary.

b. Power Rating: Four models now available: Model 9851 which will dissipate ½ watt at 85 deg. C with less than ½% change on load life; Model 9852 which will dissipate ½ watt at 125 deg. C with less than ½% change on load life; Model 9853 which will dissipate 1 watt at 70

deg. C with less than ½% change on load life; and Model 9854 which will dissipate ½ watt at 150 deg. C with less
Take 2—VAMISTOR—
than 1% change on load life. These derating curves are shown in figs. 1, 2, 3 and 4.

c. Accuracy: The standard unit is available to an accuracy of 1%, but units can be supplied to tighter tolerances by selection or by pairing.

d. Noise: Direct current flowing through a resistor causes a relatively large increase in fluctuating voltage at the resistor terminals. This added fluctuating noise is "current noise" as distinguished from "thermal noise" which is present whether current flows or not. The noise signals of both types are distributed in random fashion throughout the frequency spectrum. The power aspect of "current noise" varies inversely(1) with frequency whereas "thermal noise"(2) is uniformly constant throughout the frequency spectrum. Thus "current noise" is of major interest at audio frequencies and below, whereas at high frequencies thermal noise predominates.

Conrad(1) has proposed a convenient factor for measuring the noisiness of a resistor. $G_c = 10 \log P_n/P$ db where P = d-c loading in watts applied to test resistors whose resistance is R.

$$P_n = \frac{\text{NPSD } 10^{12}}{4R}$$

where NPSD = noise power spectral density measured in microvolts squared per cps at 1,000 cycles. G_c is called the conversion gain and has demonstrated(3) its ability to be used as a tool in measuring noisiness of resistors. Table 2 shows the test results on 1, 10, and 100 K ohm Weston Vamistors. These results compare favorably with noise figures on wire wound resistors and are superior[a] in all respects to tests conducted on carbon composition and carbon film resistors.

TABLE 2
NOISE CONVERSION GAIN DATA

Weston Vamistor VR ½ Watt to spec. MIL-R-19074A Type RI 94E1000RF			Weston Vamistor VR ½ Watt Type RI 94E10001F			Weston Vamistor VR ½ Watt Type RI 94E10002F		
No.	DC Voltage	Gc(db)	No.	DC Voltage	Gc(db)	No.	DC Voltage	Gc(db)
1	17.7v	−193.0	11	50.0v	−188.4	21	180.0	−188.5
2	17.7v	−190.0	12	50.0v	−184.0	22	180.0	−185.5
3	17.7v	−188.9	13	50.0v	−185.2	23	180.0	−181.6
4	17.7v	−183.5	14	50.0v	−189.2	24	180.0	−181.6
5	17.7v	−191.8	15	50.0v	−200.6	25	180.0	−180.2
6	17.7v	−170.3	16	50.0v	−201.5	26	180.0	−182.7
7	17.7v	−191.8	17	50.0v	−183.0	27	180.0	−184.3
8	17.7v	−191.8	18	50.0v	−199.8			
9	17.7v	−190.9	19	50.0v	−190.7			
10	17.7v	−190.9	20	50.0v	−198.2			

NOTE: Numbers 1 through 10 represent 1 K ohm; numbers 11 through 20, 10 K ohms; and numbers 21 through 27, 100 K ohms.

As stated in the paragraph on construction, the metal alloy is deposited and then dispersed throughout the body of the glaze. This, of course, gives the desirable attributes of high physical strength and toughness to the resistive coat as opposed to the usual fragility of most metal alloy elements, which are generally of elemental thickness. This dispersion has another side effect of reducing the current density in the resistive element and it is thought that this is the main reason for the marked reduction of noise in the Vamistor.

e. Short Time Overload: When subjected to the test of five times overload for five seconds, the stated permissible percentage in the specification is ½% maximum change. It will be appreciated that there are many types of short time overloads, ranging from 6¼ times the wattage for 10 seconds to 2¼ times the wattage for 10 minutes. Virtually all of these tests produce about the same percentage change. The maximum drift found under MIL-R-10509 was —.04% with an average figure of —.015%. In production every Weston Vamistor leaving the production line is subjected to a 100% test of 6¼ times the wattage for a period of five seconds. In a satisfactory resistor, it has been demonstrated that this overload can be increased up to about 16 times before any serious permanent change in resistance takes place. This test has proved to be one of the most valuable quality control checks on the production line since the change in resistance that occurs can be used as a statistical control figure indicative of many of the facets of quality of the manufacturing process.

f. Temperature Cycling: The usual test of five cycles between —55 deg C to +85 deg C specifies a resistance change within .2%. In MIL-R-10509 tests the maximum drift was found to be +.01% with an average drift of +.009%.

g. Low Temperature: In a test of 24 hours at —65 deg C, the Weston Vamistor specification allows ½% maximum change. The test results indicate a maximum drift of .01% and an average drift of .001%.

h. Applied Voltage and Voltage Coefficient: The maximum applied voltage is always a difficult thing to determine since it is not the units that pass a test that are of interest, but rather the ones that fail. Units in considerable number have been taken up to 1,500 volts before any appreciable change takes place, but by this time the wattage rating has often been very greatly exceeded. Presently, the majority of military specifications for this size unit call for 350 volts as the maximum voltage to be applied to the unit. The current figure on our commercial Weston specification is 500 volts. In general, deposited carbon resistors often suffer from a change in resistance that takes place with the voltage applied to the unit and this has often been one of the limitations of the deposited carbon type resistor. Statistically, over several thousands of units tested, the voltage coefficient of Weston Vamistors ran in the order of 1 part/million/volt applied and a conservative specification limit is set of five.

i. Moisture Resistance and Insulation Resistance: Under the moisture resistance specified in Method 106 in MIL-STD-202, the Weston Vamistor's maximum allowance is ½% change as compared with the 3% change in MIL-R-10509. In the latter test the maximum drift of Weston Vamistors was found to be .05% with an average drift of .04%. The insulation resistance at the end of these cycles of humidity, i.e., when the unit has been thoroughly soaked, gives a figure in excess of 100 megohms. However, the more general insulation resistance test on a dry unit in which there is 100 volts d-c applied to a V-block gives results in the order of 10^5 megohms.

High Frequency Performance

Perhaps the chief limitation of the wire-wound resistor is its inability to perform well at high frequencies. Certainly wire-wound resistors can be wound non-inductively to reduce the inductive effects of using wire, but inherent in any multi-layer coil is the inter-layer capacitance which is more than large enough to limit the use of wire wound resistors to d-c or low frequency a-c only. Conventional metal film resistors effectively overcome this disadvantage in that the only reactive component of any consequence that can be detected as the frequency is raised is that due to the very low distributed capacitance between end caps, usually of the order of several micromicrofarads. The Weston Vamistor has its ceramic body in the form of a tube rather than a solid rod and since the ceramic used is of the low loss, low permittivity type, distributed capacitances between the end caps average the low value of 0.9 micromicrofarad. Although the metal film is distributed

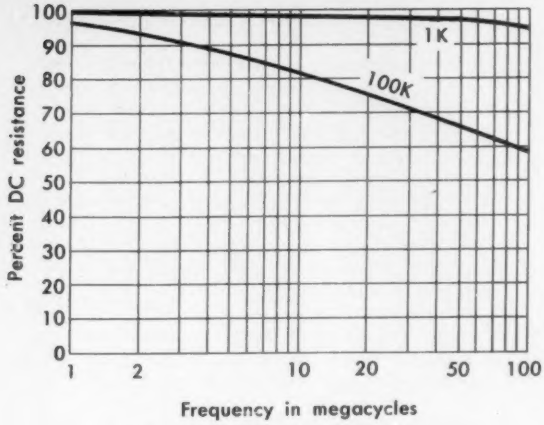


Fig. 5. Frequency characteristics

throughout the thickness of the glaze, this thickness is still small enough to give satisfactory ratios of d-c to a-c resistance (fig.5).

Formerly, if low noise was desired, a wire-wound resistor had to be used. When good high frequency performance was needed, there was no alternative to deposited carbon film-type resistors. Now for the first time a resistor is available for applications where both low noise and good high frequency performance is required. It is thought that this combination may prove to be the most valuable property of the Weston Vamistor; in being able to make a solid contribution to the state of the art of early stages of high gain servo amplifiers, preamplifiers for nuclear detectors, television camera and distributed amplifiers—any application, in fact, where low noise and good high frequency performance is required.

Nuclear Radiation

A report recently issued on reactor irradiation tests on the Vamistor indicates that the maximum percentage change is less than .2% when the units were subjected to an integrated flux of 1.4 times 10^{14} epicadmium neutrons/square centimeter. The units tested were 1 K ohms and 100 K ohms resistors, and inspection of fig. 6 indicates that virtually the same type of performance was encountered in each case. Since previously tested types of high frequency film resistors have been shown to be very radiation sensitive, this indicates a considerable potential for the Vamistor in areas of high neutron flux densities in nuclear powered systems.

Stability

The inevitable question in resistor work is how stable is the product. The really hard part of this question is defining "stability."

The 1,000-hour load life test probably comes as close to defining stability as any. This test gives a picture of what happens to a resistor when fully loaded. Components engineers, however, in almost all cases prefer to run resistors at reduced wattage, believing that this will give increased stability; the full load life test then does not fully simulate these working conditions. When studying long-term drifts in resistance of various types of resistors, it was noticed that a particularly severe test of stability occurred when a low wattage load was placed on a resistor in normal ambient temperature. Thus, load was insufficient to appreciably warm up the resistor, with the result that if any moisture could get into the resistor, there was enough voltage present to cause electrochemical etching and hence resistance change.

In states like New Jersey with high summertime humidity, this test was often most revealing. Figure 7 shows the results for some boron carbon resistors. The same test performed on Weston Vamistors, as in figs. 8, 9 and 10, shows changes less than 0.1% after 13 months. In these tests, a 1 ma load was placed on the resistors on an interrupted duty cycle so that moisture would have a good chance to enter the resistors if it were able. These tests, in progress for 13 months, are being continued to study long-term trends.

Another important influence affecting stability is whether the resistor changes in value without voltage being applied to it. Thus, shelf life tests results show a change of less than 0.2% in Weston Vamistors after 13 months. This

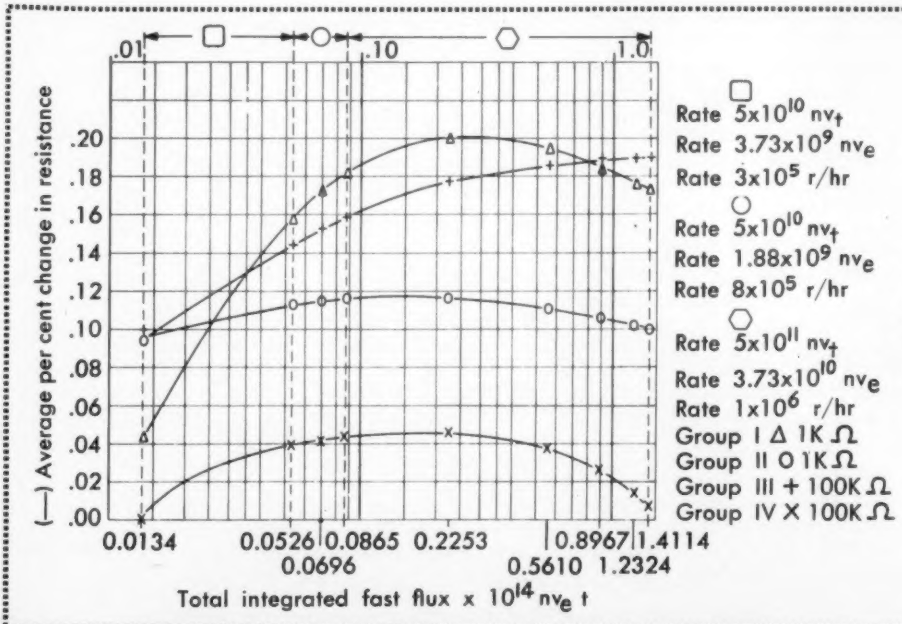


Fig. 6. Nuclear irradiation test results. Maximum resistance change is less than .2%

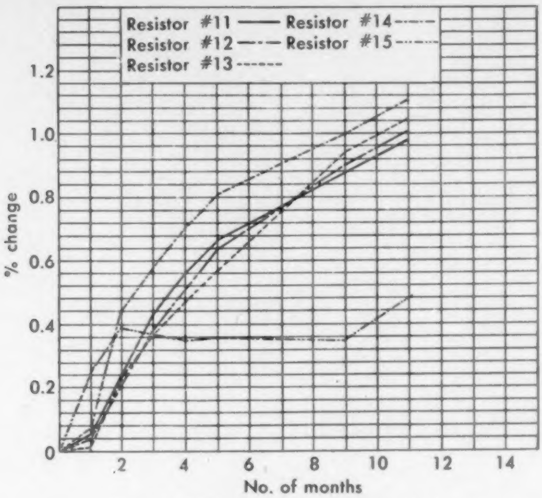


Fig. 7. 150K resistors (boron carbon)

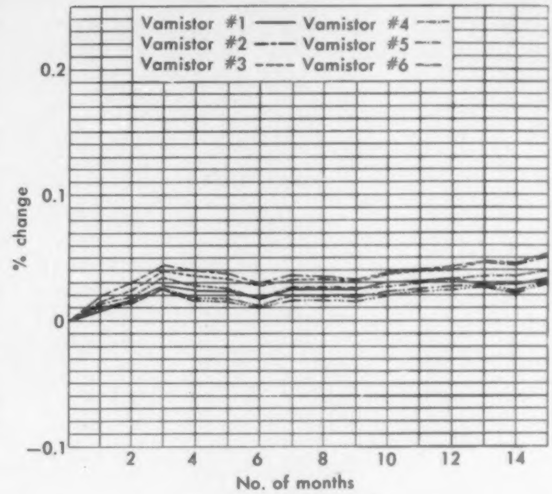


Fig. 8. 1 ma test (5K)

test is being continued in parallel with the low load test mentioned above, to give continued information on long-term drifts.

Stability requirements for applications such as computers and instruments which need to hold the resistance change to a low level for a long period of time are dependent greatly on shelf life, low load and full life load tests.

On the other hand, guided missiles spend their active life in one glorious burst and the components used must have the utmost in reliability even when working at extremely high temperatures. One common requirement for missile resistors is that after a full load run in an ambient temperature of 65 deg C the unit, still on load, shall be placed in an oven at 230 deg C for seven minutes and be required to change less than 1%. Results of such a test on the Vamistor Model 9852 are shown in Table 3 to be very well inside the specification requirement.

TABLE 3
HIGH TEMPERATURE EXPOSURE TESTS FOR GUIDED MISSILES

Resistance		Resistance Change	25°C (After test)	Net Drift
25°C	230°C	%R	Rf	%R
10599	10550	−.46	10602	+.03
10667	10579	−.83	10673	+.06
10645	10601	−.41	10661	+.16
10683	10624	−.51	10687	+.04
10397	10361	−.34	10399	+.02
10566	10489	−.73	10567	+.01

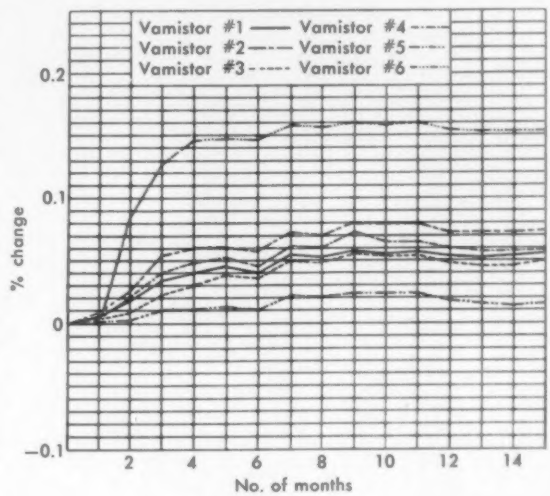


Fig. 9. 1 ma test (50K)

It should be borne in mind that the guided missile may have a long period of inactive storage before use. Thus stability requirements for such an application require shelf life as well as high temperature load life characteristics.

It is indeed fortunate that one precision resistor can span the diverse requirements of a computer needing performance for many thousands of hours and guided missiles requiring it for only a few minutes. END

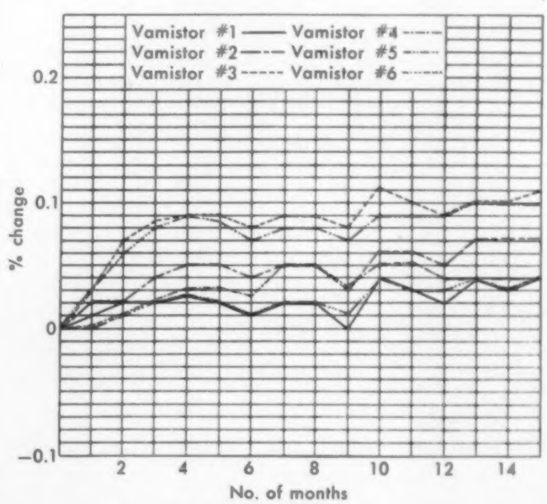


Fig. 10. 1 ma test (100K)

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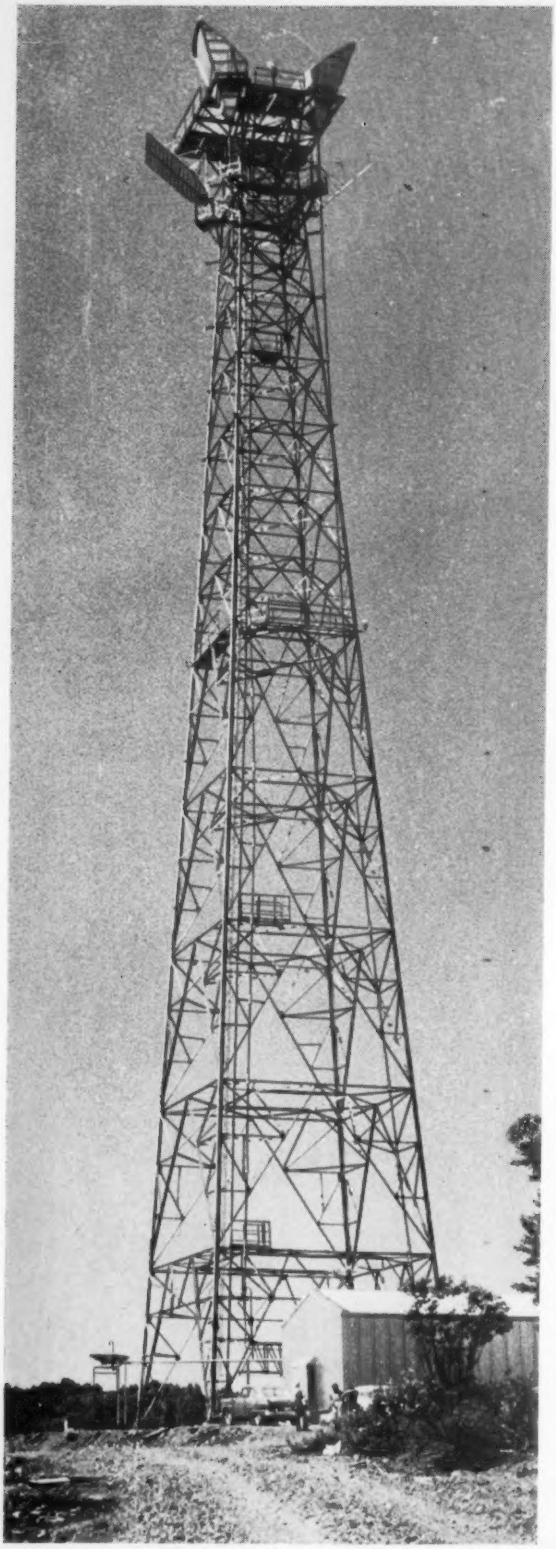


Typical radio relay tower in Western Ontario with TD-2 horn reflector antenna and light route reflector under

Radio plays big part in Canada's expanding telephone network

*S. BONNEVILLE

Radio for both long and short haul work is finding increasing use in the ever-growing Canadian telephone network. Microwave systems, operating more economically than coaxial cables, are used on high capacity routes while light route and scatter systems are providing service to more remote points with lower circuit requirements. Radio will play an even bigger part in future expansion

In recent years radio has given the telephone industry an important tool for providing telephone circuits for long distance and local use. The majority of this development has taken place in the last decade. Prior to this time circuits were obtained by means of wire lines in open wire and cable with a few circuits operating in the medium frequency (mf) and high frequency (hf) bands. The ever increasing demand for circuits in the wire field was met by developing larger capacity carrier systems. Radiation and other problems present a limit to this development.

In the United States the large circuit requirements led to the development of the coaxial cable which could handle up to 480 telephone circuits or a 2.7 mc television channel and several of these cables could be placed under the same sheath. Later, microwave systems were developed which could provide more economically the same or greater circuit capacity compared with the coaxial cable. In Canada, microwave developments occurred at a time when the installation of radio relay on high capacity routes proved more attractive than the construction of coaxial cable.

Besides the high capacity radio facilities for long haul applications developments were taking place in other fields. Light route and scatter systems were being used to provide

*The Bell Telephone Co. of Canada, Montreal

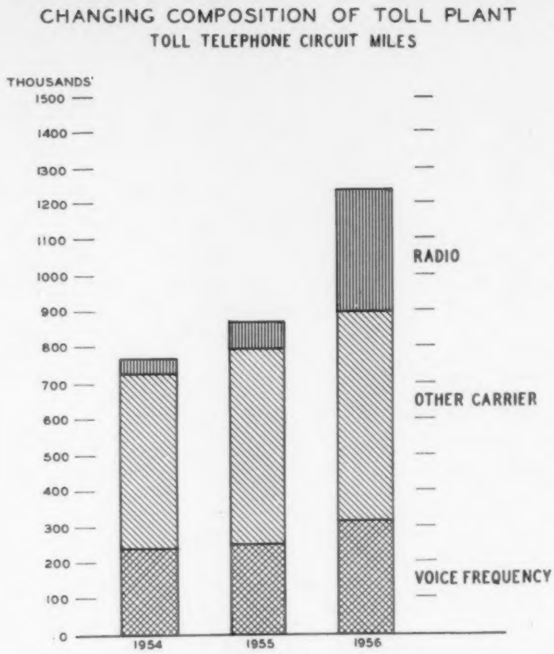


Figure 1

service to more remote points with lower circuit requirements. General mobile radio service now provides a country-wide coverage by giving service at the majority of the larger cities in Canada. Private systems supplied by the telephone systems provide the dispatching service required by many firms. It is expected that this will be supplemented by Direct Dispatch Service in the near future. Point-to-point radio systems provide low capacity facilities to remote areas where service may be required on a permanent or temporary basis. Portable radio telephone equipment for short range communication is finding greater use for both telephone and television transmission. Other types of communication involve radio links for studio transmitter operation and hand-packed sets for use in cable laying and similar operations.

Definitions of terms

Following are definitions of some of the terms used in this field:

Radio Relay System—A broadband radio system which will handle several thousand telephone circuits or several television circuits on a transcontinental basis (4,000 miles or more) and meet generally accepted telephone transmission standards.

Light Route Radio System—A radio system which will handle a hundred or more telephone circuits or a television channel over distances of a few hundred miles and meet generally accepted telephone transmission standards.

Point-to-Point Radio System—Generally a single-hop radio system used to provide a small number of telephone circuits (one to five).

Mobile Telephone Service—Radio service between a fixed telephone and a telephone in a mobile vehicle or between two mobile vehicle telephones.

Canadian transcontinental radio relay system

Approximately 30% of the long distance circuits in the Bell Telephone Company of Canada's territory operate over radio facilities, mainly radio relay. Fig. 1 shows the proportion of toll circuits in voice frequency, carrier and radio facilities for the years 1954, 1955 and 1956. On completion of the system in 1958 a similar situation will exist in the territory of the other telephone systems involved. Additional channels are now being planned for telephone use and this, with the light route systems under construction and proposed, will greatly increase the percentage. In addition to the telephone application it can be said that almost 100% of the several thousand miles of television channels are operated over microwave facilities.

The Trans-Canada System when completed in 1958 will extend from Halifax to Vancouver with branches to Sault Ste. Marie, Saskatoon and Edmonton, a total distance of some 4,800 miles. At present service is being given from Sydney to Halifax and Saint John and from Quebec to Regina and Saskatoon.

Light route systems

Light route systems providing up to 200 or 300 tele-

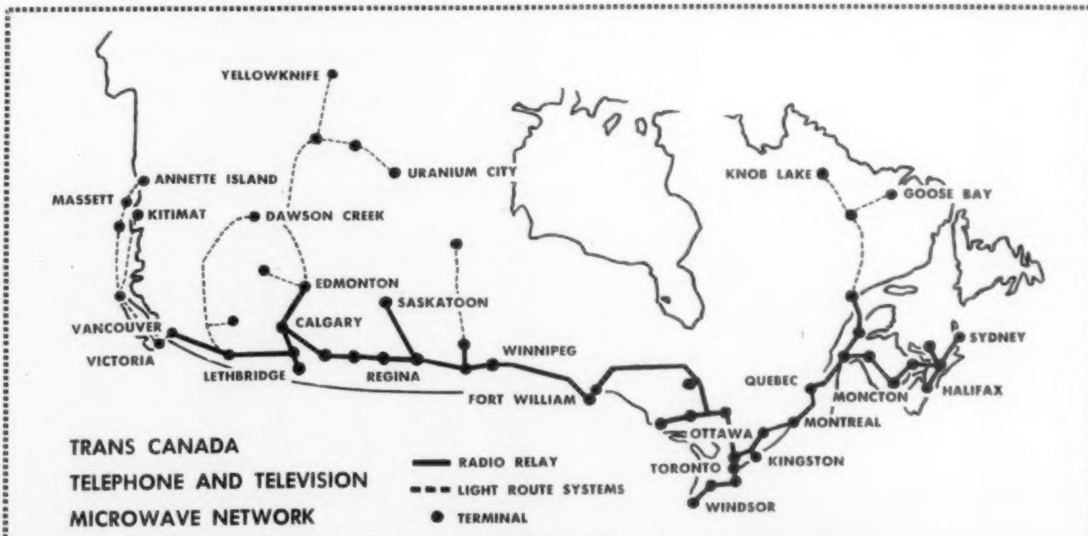


Figure 2

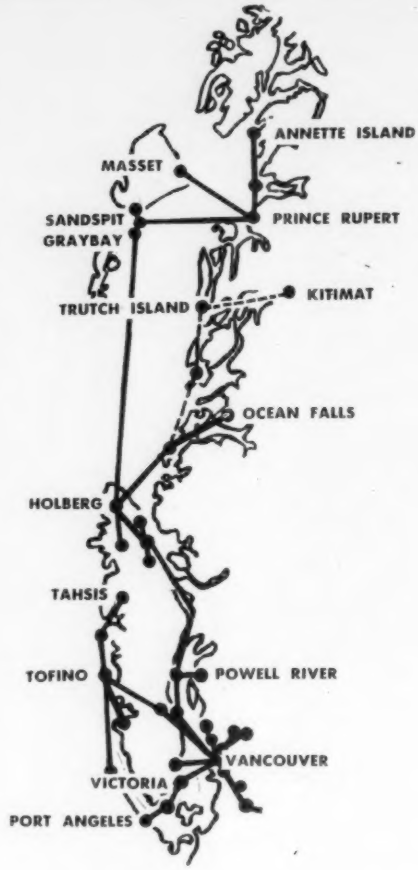


Figure 3

phone circuits and extending 200 miles or more are being installed and planned at many locations in Canada. Fig. 2 shows the route of the Trans-Canada microwave system and many of the light route facilities including scatter. These systems are provided by equipment operating at frequencies in the vhf, uhf and shf bands. In British Columbia a network of circuits provide service up the coast as far north as Annette Island in the U. S. A. and provides service to the Queen Charlotte Islands, Prince Rupert, Kitimat, Vancouver Island and many other locations. These are shown in fig. 3.

Point-to-point systems

Widespread use is made of point-to-point circuits. Such a system fills the need for circuits between two specific points which may be up to 50 miles or more apart. These systems normally handle up to five circuits, many of them are single channels. The equipment employed for this purpose is generally mobile or similar equipment which can be produced at a reasonable cost per circuit. Where more than one circuit is required the band width is widened and multiplex equipment superimposed. These facilities can be used to provide temporary circuits until permanent wire circuits are made available or they might be used to give permanent service to islands and remote points where wire facilities could be uneconomical.

Up to now the majority of the point-to-point telephone circuits have operated in the 152-174 mc band. It is expected that in the future these facilities will be assigned to the 132-148 or to higher frequency bands starting with 450 mc. The majority of the original point-to-point circuits in B. C. operated in the mf or hf bands. These are generally being replaced with circuits in the higher band.

Mobile telephone service

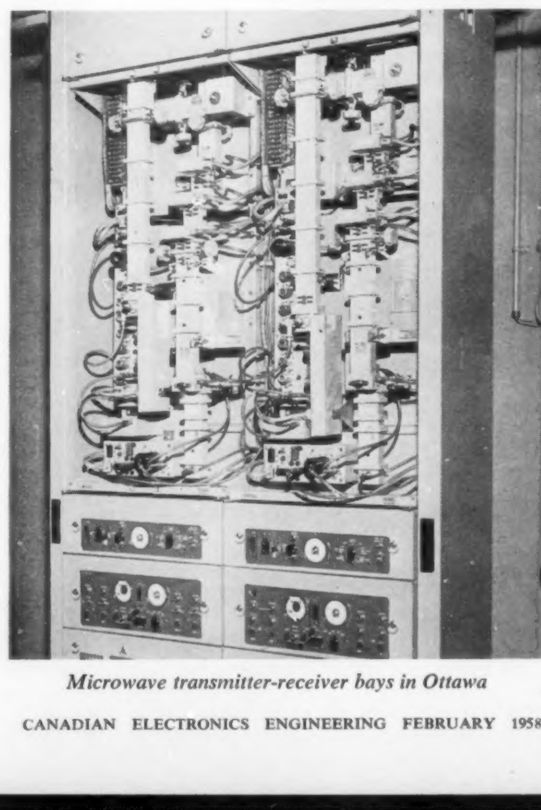
In the mobile field three types of service are given: namely general, private, and direct dispatch, the latter being called restricted common carrier by the Department of Transport. In order to meet the requirements of all types of customers the general classification is broken down into three classes of service.

(a) General Service which is a two-way service between any regular telephone and any mobile unit or between two mobile units.

(b) Dispatching Service which is a two-way service between a particular telephone at the dispatching office connected directly to the mobile operator and specified mobile units of the same customer.

(c) Signalling Service is a one-way service from any land telephone to mobile units equipped only for this service.

In the case of a private system no connection is made to the telephone customers, the service being two-way from a dispatcher directly to the units in his fleet. Direct dispatch service is similar to private service but makes provision for several customers to share a common radio



Microwave transmitter-receiver bays in Ottawa

Service work on a typical mobile installation

channel. Each customer's usage is recorded separately.

Under the general mobile service classification there are some 43 base stations giving service to approximately 1,225 mobile units. In the private system service there are about 160 base stations serving some 1,500 mobile units. Direct Dispatch service is now being installed and should be ready for service at many of the locations by the end of the year.

Miscellaneous radio services

In addition to the radio services already mentioned portable equipment is available to set up temporary or emergency circuits on short notice. Some of these installations are mounted in trailers and others in packaged forms. These systems operate in the 152-174 mc band and provide from one to three or four telephone circuits.

Other radio equipments are used for studio transmitter television links and for television pickup purposes. Portaphones have been licensed to provide a portable set in connection with the mobile service; in addition these are used by the telephone plant forces for laying cable and similar purposes.

Consideration is now being given to the provision of a one-way signalling service which would be received on pocket-size equipment. The received signal which consists of a tone advises the person called to telephone some prearranged number. No doubt this will eventually result in a two-way arrangement and will provide a personal extension to the telephone service.

Possible future developments

Within the next few years it is expected that our long-haul TD2 system will have exhausted in many sections all the available channels. Some relief will be provided by bypass arrangements around the larger cities.

By the time additional channels are required over and above that provided by the TD2 system it is expected that a higher capacity long-haul system will be available designated the TH. The TH radio equipment in addition to providing more radio channels will also be a much higher capacity system. Eight two-way radio channels (six working and two protection) will each carry some 1,860 telephone circuits or two television channels (monochrome or color). This system will operate in the 5,925 to 6,425 mc band. Arrangements will be available to operate this system over the same antenna (horn reflector) and wave guide (three-inch circular) as the TD2.

For light route operation a TJ system is now under development which will operate in the 10,700 to 11,700 mc band. This system will meet the needs for many short-haul services with a maximum length of 200 miles for telephone and about 100 miles for television. In view of the high frequency involved the repeater spacing will probably average about 20 miles. There will be three two-way working channels and three protection channels. Each working channel will be capable of handling 240 telephone circuits or two television channels (one in each direction). Alarm, control and order circuits are also transmitted over the radio system.

Although microwave radio facilities in the past have been used in the main to provide long distance facilities, it has been predicted that these facilities will be just as important in the short-haul field. For this purpose is envisaged the use of frequencies between 16 and 30 kmc. Possible applications seen at the present time would be to provide communication for trunks between central offices, between concentrators and between concentrators and central offices and circuits to customers' premises.

A forward look into the radio field from the standpoint of the Telephone Common Carriers in Canada indicates future developments which in the next decade will far surpass those in the past ten years. END

High isolation to insertion loss ratio of modern ferrite isolators is pointed out with examples. Various applications are mentioned and the design techniques involved in selecting an isolator are described. A Nomogram for Unilateral Isolation is introduced, and its use in conjunction with the Rieke Diagram for the magnetron or oscillator being used is illustrated by an example of limiting magnetron frequency pulling

Designing with ferrite isolators

WILLARD A. HUGHES*

Ferrite Isolators are precision designed and manufactured components which replace padding attenuators in microwave circuits to isolate the oscillator from the transmission line. The primary advantage of a ferrite isolator over a padding attenuator results from the non-reciprocal transmission characteristic of the ferrite device. Insertion loss or attenuation in the forward direction of energy flow is drastically reduced by virtue of this transmission characteristic in isolators manufactured today.

In the selection of isolators, the main criterion is the ratio of decibels of isolation to decibels of insertion loss. This ratio is referred to as the reverse-to-forward loss ratio. Until recently, the best value of the ratio for commercially-available ferrite isolators was between 20 : 1 and 30 : 1. Today, however, isolators with ratios of 100 : 1 and better are being manufactured on a quantity basis.

Two typical examples of isolators with high reverse-to-forward loss ratios are shown with their operational curves in figs. 1 and 2. Designed specifically for laboratory test set-ups, the isolator shown in fig. 1 has a reverse-to-forward loss ratio of 60 : 1 at the middle of its band. The low power isolator, fig. 2, for narrow band operation has a reverse-to-forward loss ratio of greater than 100 : 1 at the middle of the band. High ratios for these particular isolators are obtained by the simultaneous use of three phenomena:

(1) the ferrite is used as a resonant dielectric slab,
(2) the ferrite causes field displacement to occur, and
(3) the ferrite uses the field resonance phenomenon.

Isolator functions

Among their important applications in microwave systems, ferrite isolators are used to reduce frequency pulling of an oscillator or generator caused by reflections from the load. By limiting frequency pulling, it is possible to stay within a specific band of operation. This is particularly important in radar systems where it is necessary to stay within the pass band so that the afc will lock onto the signal.

Reduction of long-line effects is another advantage in the use of ferrite isolators. Long-line effects result when the admittance of the load is in the wrong phase to enable the oscillator to function stably at one frequency. Oscillators can have two stable frequencies in which they can operate under the same load condition. Under the condition of long-line effect, if the frequency is pulled as little as 1 mc, the phase changes considerably, spreading the oscillator spectrum out over a wide range rather than a finite band. Again in radar systems, a long-line effect prevents the afc from locking onto the signal. In addition, the i-f cannot operate efficiently under this condition since only a small portion of the reflected signal will be in the pass band of the i-f. It has been determined that an isolation of approximately 6 db is sufficient to eliminate long-line effects in a six foot X-band transmission line.

A further function of isolators is to permit broad band operation. Broad banding eliminates peaks and dips in load impedance which are seen by the oscillator with no isolation in the line. The isolator shows the oscillator a more constant total load, and the oscillator in turn puts out a more constant power.

Matching crystal detectors

Isolators are often used in systems incorporating crystal detectors. Crystal detectors themselves are very difficult to match over an entire band, since they respond with peaks and dips of considerable amplitude. An isolator of only 10 db isolation placed in front of a crystal will flatten response to the point where a good match is evident over all frequencies within its band of operation.

Another additionally gained advantage in the use of isolators is that of magnetron window protection from arcing. When an arc occurs in a nonisolated line, it travels back down the line until it reaches the magnetron. At this point, after a short period of arcing, the magnetron window will often burn out, destroying the magnetron. If, however, an

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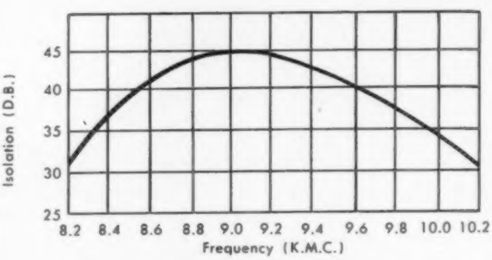
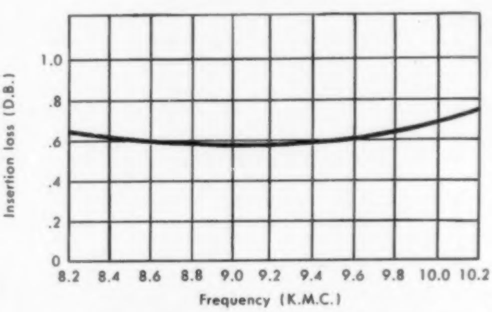
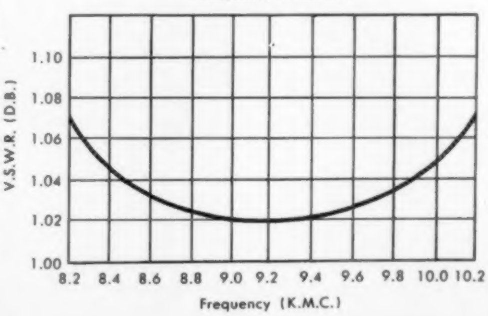
Fig. 1. Reverse-to-forward loss ratio for the ferrite isolator shown above is 06 : 1 at the middle of the band; ratio at the ends of the band is 50 : 1. This particular isolator, Kearfott W 177-2C-1, is designed specifically for laboratory bench work. It weighs 1½ pounds and measures 2½ inches long. Broad band operation spans 8.2 to 10.2 kmc range







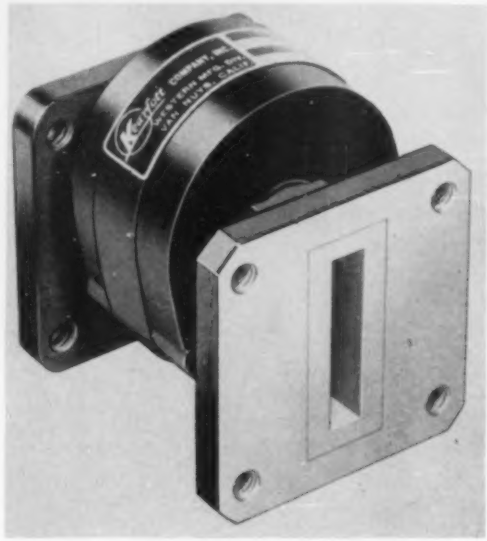
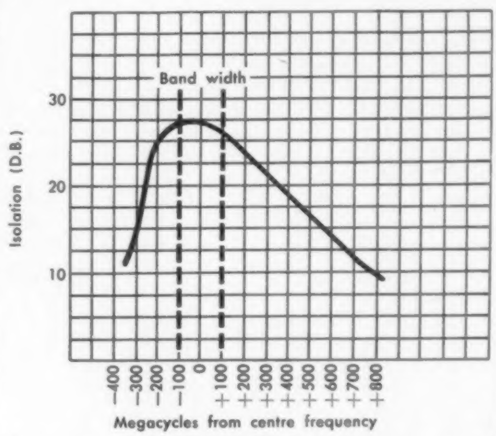
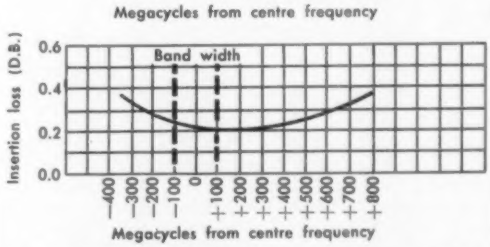
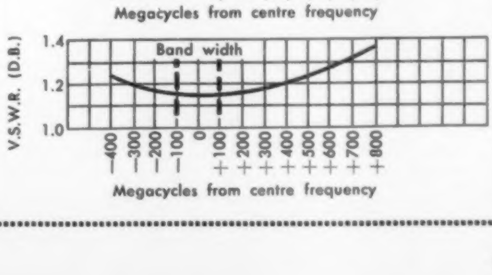


Fig. 2. A low power ferrite isolator, performance curves shown below, with a reverse-to-forward loss ratio of 100 : 1 at the middle of the band. Developed for narrow band operation, the isolator, Kearfott W 165-1A-1, can be fabricated to cover any 200 mc band within the 8.2 to 12.4 kmc range. Less than two inches in length, it weighs only 10 ounces







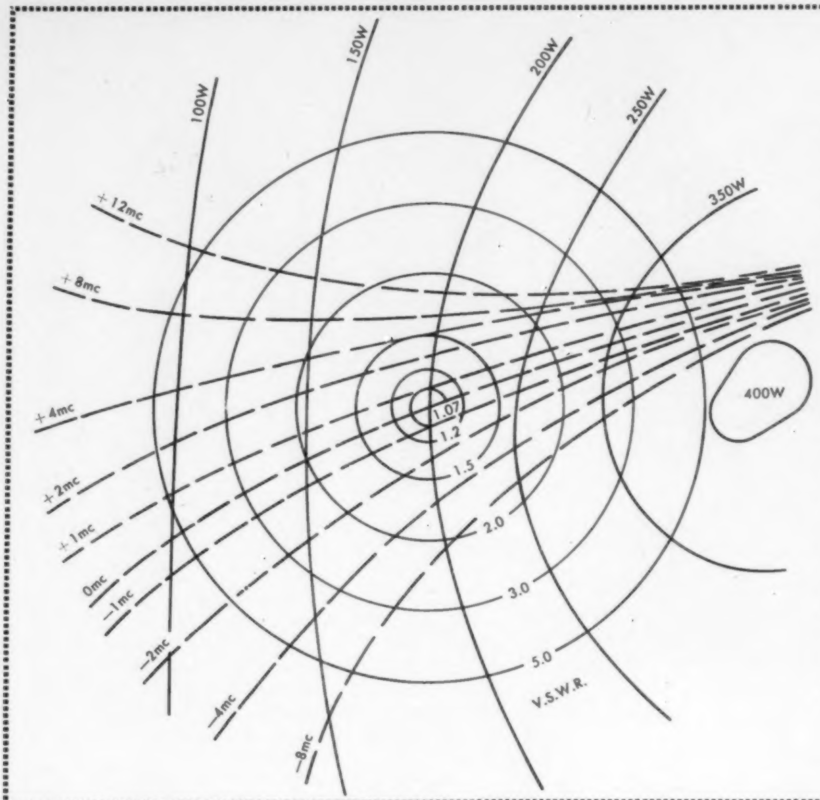


Fig. 3. Rieke Diagrams are supplied by magnetron manufacturers to aid microwave engineers in their circuit design. This one is similar to that of the 6429 magnetron. The amount of frequency pulling on the magnetron can be determined by finding the two points of intersection of the power operation line, the mismatch VSWR line and the frequency pulling lines. By placing an isolator in the transmission line, it is possible to reduce the mismatch seen by the magnetron. This places operation within a smaller area described by a smaller VSWR mismatch circle. The result then shows dirctly the lowered amount of frequency pulling.

isolator is placed in the line, the arc will stop at the isolator, where the ferrite material will dissipate the high-power arcing energy with no detrimental effects to the magnetron or the isolator. From the standpoint of the magnetron's high cost, protection afforded by the use of an isolator is generally considered by designers to be enough justification in itself for its use.

It is interesting to note that during actual testing of a high-power isolator rated at 300 watts average power, a dead short was placed across the load and 300 kw peak power put into it. Arcing energy in the isolator reached four times this value. After arcing continuously for two hours, there was no damage to the magnetron or isolator.

Selection of isolators

Isolators are generally selected on the basis of maximum frequency pulling to be allowed. The additional functional advantages already mentioned are then incorporated in the circuit automatically.

When actually choosing an isolator, a microwave designer must know two things: (1) how much frequency pulling the oscillator will stand; and (2) what VSWR the load produces. From these two parameters, the amount of isolation required can be obtained. The number of decibels of isolation can be determined by the use of two sets of curves: the first is a Nomogram for Unilateral Isolation, which can be used for the solution of all isolator attenuation problems; the second is a Rieke Diagram for the particular magnetron or oscillator being used.

The following typical example will show how a microwave systems designer would go about determining isolation needs and carry through totally to the point of actual selection of a particular isolator.

A typical application of an isolator is to limit frequency pulling in a magnetron. Magnetron manufacturers supply users with Rieke Diagrams for the particular magnetrons purchased. These Rieke Diagrams show power and frequency ranges within particular VSWR mismatch regions. A typical Rieke Diagram is shown in fig. 3 for a high power magnetron similar to Type 6349, with which many designers are familiar. Assume it is desired to limit the frequency excursion of the magnetron between ±1 mc at 200 watt operation. If the load has a VSWR of 1.5, then the VSWR seen by the magnetron looking into the isolator should be no greater than 1.07. This is determined from the Rieke Diagram by finding the maximum VSWR circle on the 200 watt power operation line which does not exceed or fall outside of the ±1 mc frequency operation lines.

With the 1.07 VSWR value, enter the Nomogram for Unilateral Isolation, fig. 4, on the vertical scale. If the mismatch seen by the magnetron is 1.5, then project the 1.07 value to the 1.5 curve. Projecting this point in turn to the horizontal scale, the first approximation of 16 db is obtained for the required isolation. At this point, a particular isolator can be selected. By reversing the procedure of using the curves, it can be determined whether or not this particular isolator can fill the requirements.

Check available hardware

It is generally necessary to specify special isolators for particular applications. It is advisable, however, to check on-the-shelf isolators to see if available units will fit a particular need, in order to reduce costs and save time.

In looking over a list of standard isolators, the designer may select a typical one such as is shown in fig. 5. From

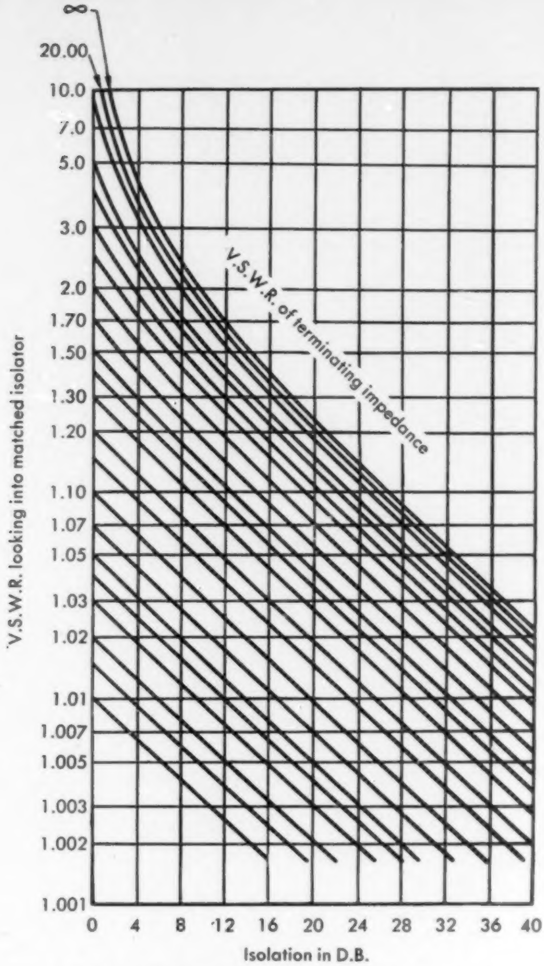


Fig. 4. Nomogram for Unilateral Isolation can be used to determine the amount of isolation required for a particular load mismatch. If, for example, the isolation is 16 db and the load has a mismatch of 1.2, then the magnetron sees a VSWR of 1.03 as a result of the attenuated load

the curves for this particular isolator which has been chosen as an example, it can be seen that the isolation over its band of operation is a minimum of 20 db and the VSWR is a maximum of 1.03. Using these figures, the Nomogram for Unilateral Isolation is entered with 20 db on the horizontal scale. This point is then projected up to the 1.5 VSWR line. Projecting the resulting point to the vertical scale gives a VSWR of about 1.04 seen by the magnetron as a result of the load after attenuation. This value must be multiplied by the VSWR of the isolator itself to give the total VSWR seen by the magnetron, 1.04 x 1.03 = 1.07. Since this VSWR of 1.07 is equal to the 1.07 originally required to hold the frequency excursion within ± 1 mc, this particular isolator will satisfy requirements. The 20 db isolator chosen has a high reverse-to-forward loss ratio of 30 : 1.

Since the Rieke Diagrams vary with different magnetrons, particular system requirements will have to be determined with the Rieke Diagram for the specific magnetron used. However, in all cases isolation calculations are performed in the same manner as indicated, using the Nomogram for Unilateral Isolation. END

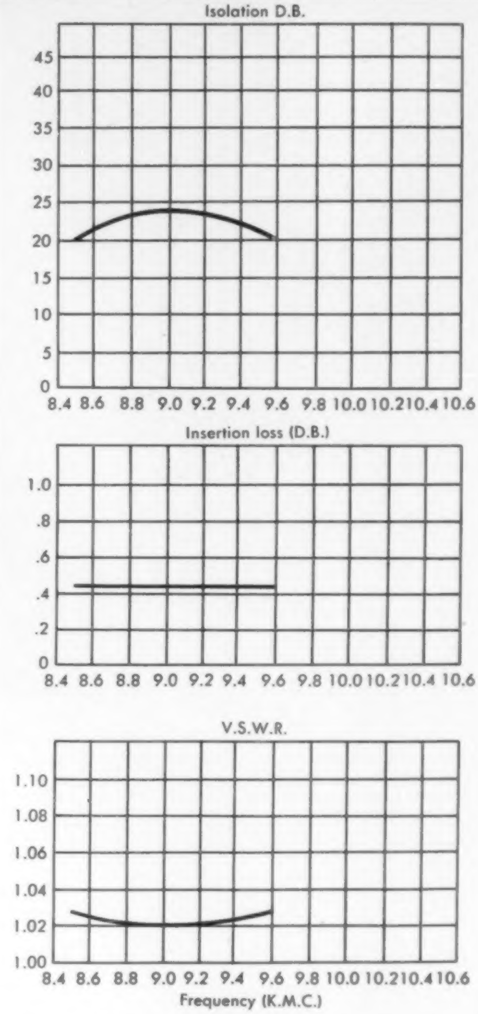
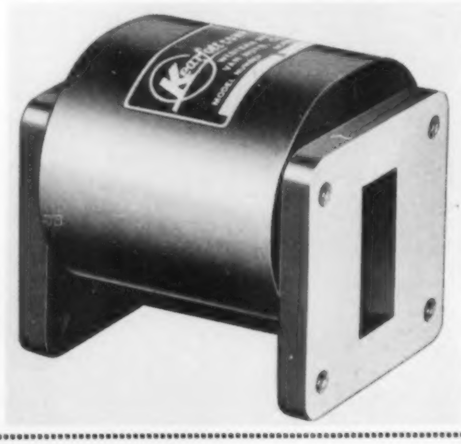


Fig. 5. These curves used in the example are for a standard Kearfott W 668-2A-2 isolator rated at 300 watts average power. The photograph shows the waveguide portion surrounded by a permanent magnet; inside it is a thin slab of ferrite.



Nomograms based on equations for the percentage ripple transmission of RC and LC filter sections assist greatly in speeding up the roughing out of power supply filter designs. Since supply frequency in the range 50 cps to 5000 cps is included in the charts as a variable, the effects of frequency variations can easily be checked.

Fast filter design using nomograms

A. E. MAINE*

Two nomograms are given which enable single or multiple section power supply smoothing filters to be rapidly designed in outline for any power supply frequency in the range 50 cps to 5 kc. This wide range covers aircraft and most guided missile supply frequencies, and the nomograms give directly approximate component values without the use of multiplying factors. A further useful feature is that changes of filter performance due to supply frequency changes can be assessed directly from the charts. The nomograms are primarily intended as a rapid means for roughing out a filter design, the resulting component values being checked later to ascertain that rectifier and capacitor ratings are not exceeded. If component changes are required, new values can be quickly derived from the charts.

Filter equations

(a) The ripple transmission, expressed as a percentage, for a capacitor connected directly across the output of a full wave single phase rectifier is given very approximately by:—

$$r\% = \frac{E_{ripple}RMS}{E_{dc}\,output} = \frac{\sqrt{2} \times 100}{2\pi f_r\, R_L C} \quad \ldots\ldots\ldots (1)$$

where, f_r = lowest ripple frequency (twice supply frequency)
R_L = load resistance in ohms
C = shunt capacitance in farads.

(b) The ripple transmission of an *RC* filter section with a series resistor arm and a shunt capacitor is given by:—

$$r\% = \frac{100}{1 + 2\pi f_r RC} \quad \ldots\ldots\ldots (2)$$

In practical *RC* filters, ωRC is much greater than unity and consequently equation (2) may be simplified to:—

$$r\% = \frac{100}{2\pi f_r RC} \quad \ldots\ldots\ldots (3)$$

The nomogram of fig. 1 solves the above equation directly, and if the factor "$\sqrt{2}$" is introduced the chart is also applicable to equation (1).

(c) The ripple transmission of an *LC* low pass section is given by equation (4), on the assumption that the series reactive arm has a value at least 10 times greater than the shunt reactance at the operating frequency:—

$$r\% = \frac{100}{(2\pi f_r)^2 LC - 1} \quad \ldots\ldots\ldots (4)$$

where L = series inductance in henrys
C = shunt capacitance in farads.

*The De Havilland Aircraft of Canada, Limited
Guided Missile Division, Toronto.

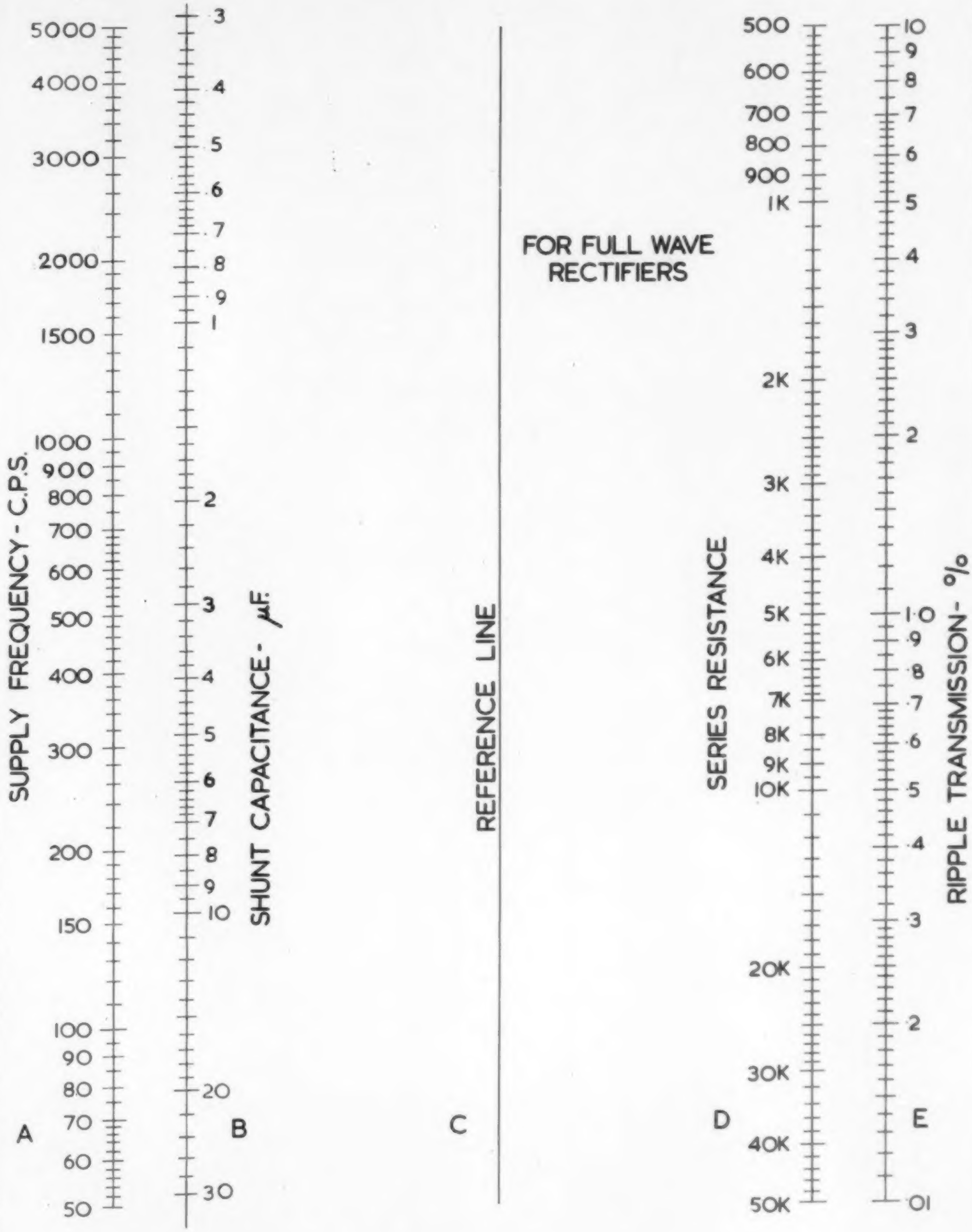


Fig. 1. RC filter sections

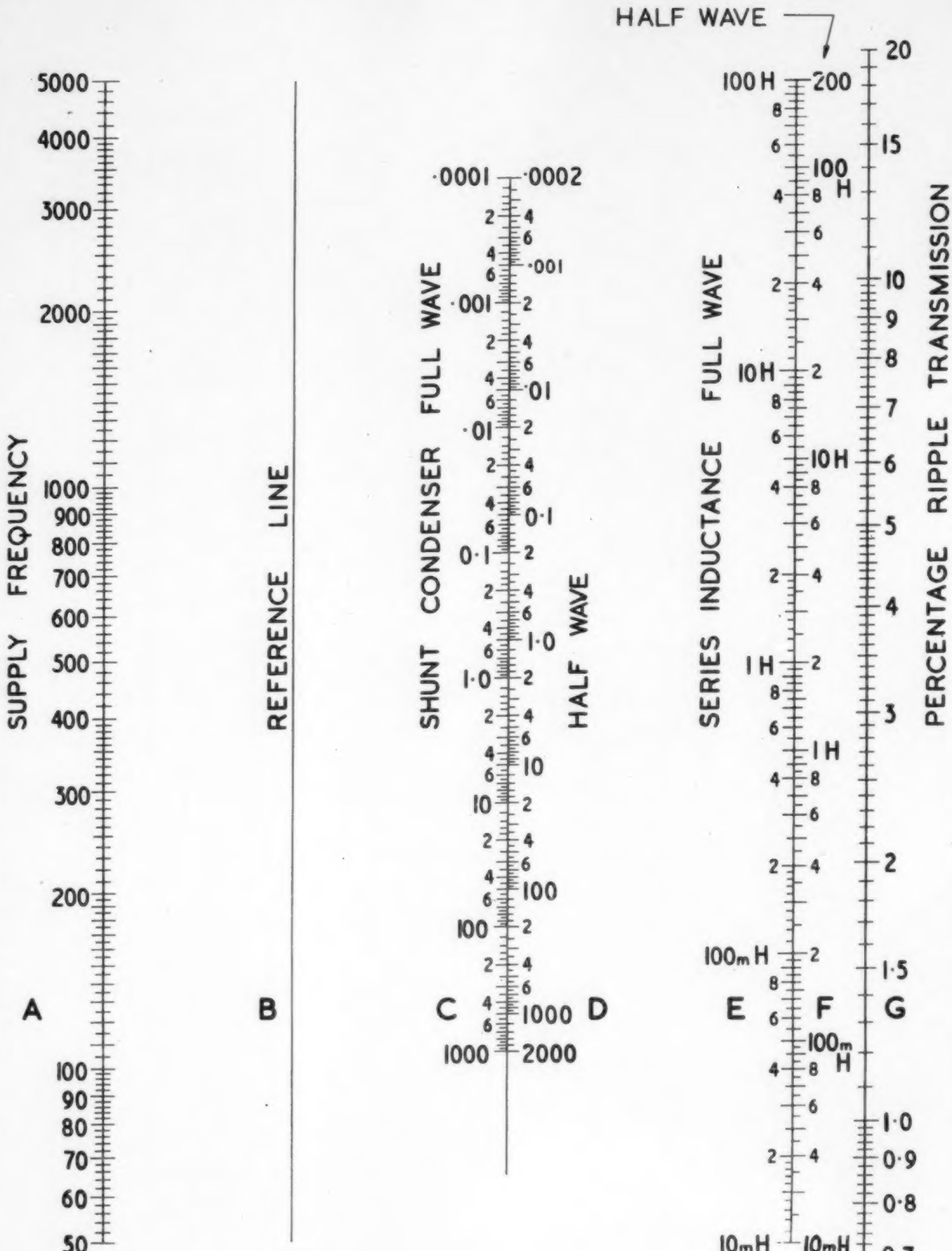


Fig. 2. LC filter sections

The nomogram of fig. 2 gives particular solutions of this equation.

Using the nomograms

The approximate design method and use of the nomograms is best illustrated by considering an actual example.

A power pack supplied from a 400 cps source and employing a capacitor input filter is required to deliver a total of 250 ma at 300v dc with less than ¼% ripple present in the output. A second output, derived from the first, is required to give 200v dc at 2.5 ma with less than 5 mv ripple. Design a suitable filter system.

(1) Calculate equivalent load resistance,

$$r = 300/.250 = 1200 \text{ ohms.}$$

(2) Choose a ripple transmission value for the first capacitor in the range 5–10%. Low values involve high peak currents which may damage the rectifiers; this must be checked subsequently. For the example a value of 10% is taken.

(3) Divide 10% by $\sqrt{2}$ and enter the result, 7.07% on scale E of fig. 1. Using a straight-edge join this point to 400 cps on scale A and note an intersection on the central reference line C.

(4) Re-position the straight-edge to align with the intersection on scale C and 1200 ohms on scale D. The required capacitor value is read from scale B where the straight-edge projects and is found to be 2.3 mfd. A nominal value of 2.5 mfd may be selected. To give the required overall ripple transmission of ¼%, a second LC section is added which must have a transmission of 2½% or less. To give a design margin, 2% is chosen.

(5) Turn to the second nomogram and set a straight-edge to join 2% on scale G with 400 cps on scale A and note an intersection with the reference line B. Pivoting from this point, the straight-edge can be positioned to cover a wide range of LC values given by intersections of the straight-edge with scales C and E. If a value of 2 mfd is chosen, the associated inductance, read from scale E is 1 henry.

An RC filter may be used to give the second smoothed output, with the series arm acting both as a voltage dropping resistance and a filter element.

(6) Calculate the value of the series resistance

$$R = 100/.0025 = 40K$$

The ripple present on the 300v dc line is 0.75v rms (i.e. ¼% of 300v); consequently a transmission not exceeding 0.66% is needed in the RC section. To give a design margin, a value of 0.5% is taken.

(7) Use the first nomogram and set a straight-edge between 0.5% on scale E and 400 cps on scale A. Note an intersection with the central reference line.

(8) Re-position the straight-edge to align with 40K on scale D. Read off the required capacitor value, 1.0 mfd, from scale B.

At this stage, all the required component values have been tentatively established and it is necessary to check that rectifier ratings are not exceeded. Assuming the values to be satisfactory in this respect, the complete filter arrangement can be set out and takes the form shown in fig. 3.

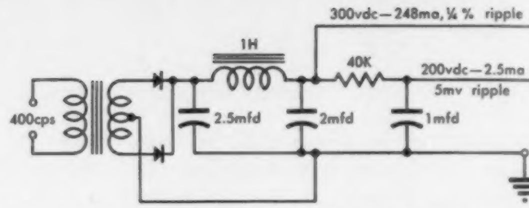


Fig. 3. Schematic diagram of complete filter arrangement

Design notes

(a) The range of the R and C scales of the first nomogram (fig.1) can be extended by multiplying one scale by a factor (10 or 100) and dividing the other scale by the same factor.

(b) The range of the L and C scales of the second nomogram (fig. 2) can be extended in the same way.

(c) For a detailed design technique for capacitor input filters see references (1) and (2).

(d) For choke input filters, the first choke should be above "critical" for the condition of maximum load resistance as determined by:—

$$L_{critical} = \frac{r_s + R_L}{3\pi f_r} \quad \ldots\ldots\ldots\ldots (5)$$

where, r_s = total resistance of diode ac supply circuit

R_L = load resistance.

(e) Assuming an above-critical inductance for the first choke, the ripple input to the filter is approximately 47% of the dc value for a single phase full wave rectifier. The ripple is reduced by the input choke and the first shunt condenser according to equation (4).

(f) Rectifier peak current for the choke input case can be determined from the following:—

$$i_p = I_L + \frac{E_p \times 0.2}{2\pi f_r L_1} \quad \ldots\ldots\ldots\ldots (6)$$

where E_p = peak ac supply voltage.

For capacitor input filters references (1) or (2) should be consulted.

(g) In general a two-stage LC filter is more efficient than a single section providing that the individual transmissions are the same and not more than about 10%.

(h) Especially when using high conductance junction rectifiers check filter section LC values to ensure that their natural frequency is well removed from the power supply frequency, otherwise undesirable resonance effects may arise.

Conclusions

The nomograms provide a rapid means for working out filter-component values and the results, though approximate, are often satisfactory for actual designs. More importantly, the charts enable many rapid trial designs to be carried through and thus ease design work in the early stages. END

REFERENCES:

1. *Schade, O. M. "Analysis of Rectifier Operation", Proc. IRE, July 1943, pp 341-361.*

2. *"Radiotron Handbook" (book), pub. Radio Corporation of America, p. 1161.*

New manufacturing techniques with different materials had to be evolved for the video recording tape used with the Ampex Video Recorder. Head pressure on the tape is 20,000 lbs per square inch and coating temperatures are around 240 deg C. It is expected that tape will eventually be used in video to the same extent as it is today in radio.

Video tape withstands tremendous heat, pressure and abrasion

*L. F. BENNETT

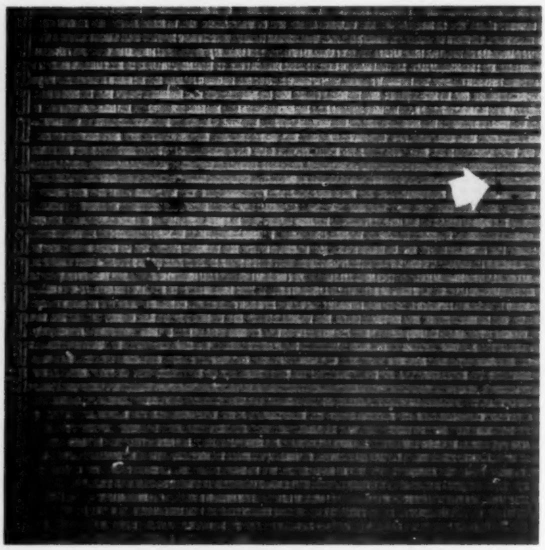


Fig. 1. Scuff marks and scratch on tape surface

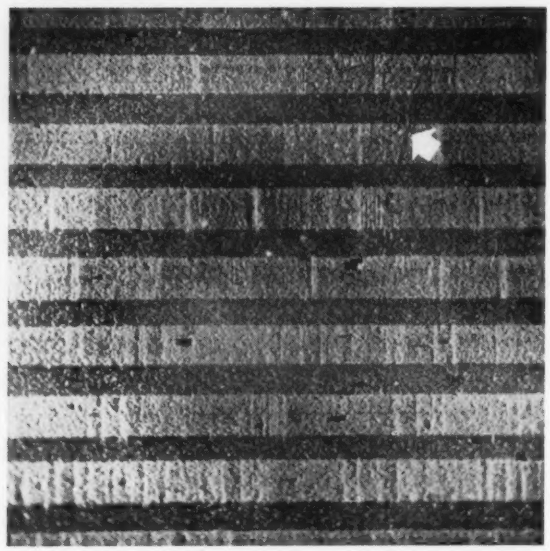


Fig. 2. Minute scratch on the tape surface

At first it appeared an almost insurmountable task to make a tape capable of meeting the demands of the Ampex Video Recorder.

It had to work with a recorder system which consists of four recording heads mounted on the outer circumference of a 2-in. diameter rotating disc, the heads being spaced approximately 90 deg. from each other. The rotational speed of the disc is 14,400 rpm (240 rps) giving a relative head to tape velocity of about 1,500 in. per second or approximately 85 miles per hour. The calculated pressure of the head on the tape is 20,000 pounds per square inch and the size of the head is 10 mils. This gives a brief description of the difficult conditions which had to be met.

The tolerances involved in manufacturing this tape are in the region of 30 millionths of an inch and compared with audio recording there is a need to be able to put ten times as much information on one inch of video tape as on the audio tape. Thus there are about 20,000 bits of information on each inch of video tape. There is virtually no margin of error or manufacturing tolerance available.

The appearance of two kinds of imperfections on the surface of the tape is shown in fig. 1. This is a photomicrograph of a small portion of video tape, on which recording has been impressed. The video modulation is clearly visible along each track. The 240 cps control track pulses are shown to the left of the illustration. These pulses are recorded longitudinally and the effects of the individual laminations of the recording head are clearly visible. Imperfections, in the shape of scuff marks are shown to the left of the illustration and a scratch is seen on the right hand side. Fig. 2 has a still larger magnification and a minute scratch is shown in the upper right hand corner. These all affect the picture during playback.

*Canadian Military Electronics Standards Agency, Ottawa

New coating material

The first design problem was to formulate an entirely new coating material, with a more durable base and greater output, and to orient the coating across the tape instead of in a longitudinal direction. However, the most difficult of all requirements was to develop a binder capable of meeting the terrific pressure, high temperature and abrasion involved. It has been estimated that coating temperatures around 240 deg C are met when using this tape.

A polyester backing is used because of the need to withstand the high stresses encountered. This, however, presents a problem in that the manufacturing tolerances of this type of backing are in the vicinity of 5% and when irregularities in the base material cause a change in the uniformity of thickness, across the tape, of 1 to 2%, it will not track satisfactorily; it will wrinkle, run off the capstans or jam against the guide posts. Therefore, not more than 10 to 20% has been the useful yield from one batch. To illustrate the initial difficulties met, one manufacturer made 100 rolls of special tape for this project and only three were completely satisfactory. Extensive research and engineering have now increased this to about 50% per batch.

Ferro magnetic oxide coating

The ferro magnetic oxide coating is far different from that of audio tape and is required to have an extremely high output because the head size had been reduced to 10 mils from 90 to 250 mils usually found in the audio recorder. It should also be noted that the video tape has to be capable of recording up to 5 mc whereas the ordinary tape is seldom required to record higher than 15 kc. This again influences the type of coating to be used.

Variables which have an effect on the output of the coating are: (a) Variation of the pigmentation, (b) Uniformity of dispersion, (c) Drying characteristics, (d) Surface smoothness, (e) Granularity, and certain other factors.

When recording video, wavelengths of only .0003 in. must be recorded, therefore imperfections in the region of 30 millionths of an inch will cause drop-outs. These take the form of white or black dots on the screen. Drop-outs are usually caused by loss of intimate contact between tape and recording head (fig. 3). It has been found that slight nodules and other irregularities of the coating cause drop-outs and in certain circumstances even a particle of dust may be sufficient to cause this trouble. As a general rule these imperfections must not occur more than once in every 15 to 20 seconds of viewing time.

A further cause of drop-outs is the recording heads themselves in that if they are not perfectly smooth they cause abrasion of the coating and pick up particles which cause them to lose contact with the tape. Actually the heads have to be machined to very close tolerances and polished or they will cut the tape. This is easily understood considering the head to tape speed and the pressures involved (fig. 4).

Friction at high speeds

One of the factors which is common to all video tape recorders is the high speed of the tape over the heads or alternatively, as in this case, the heads across the tape. The friction thus caused produces high temperatures and therefore a tendency for the softening of the ferro magnetic coating on the tape. One manufacturer has estimated that the temperature involved is around 240 deg C. The high speeds involved also cause excessive tape wear and this has been one of the most difficult problems to overcome. The excessive wear does not, as might be supposed, cause loss of definition of the signal, in fact the reverse may occur. It is the signal to noise ratio which becomes intolerable and this indicates the end of the useful life of the tape.

Fig. 3. Signal dropouts caused by irregularities as small as 30 millionths of an inch on magnetic tape surface

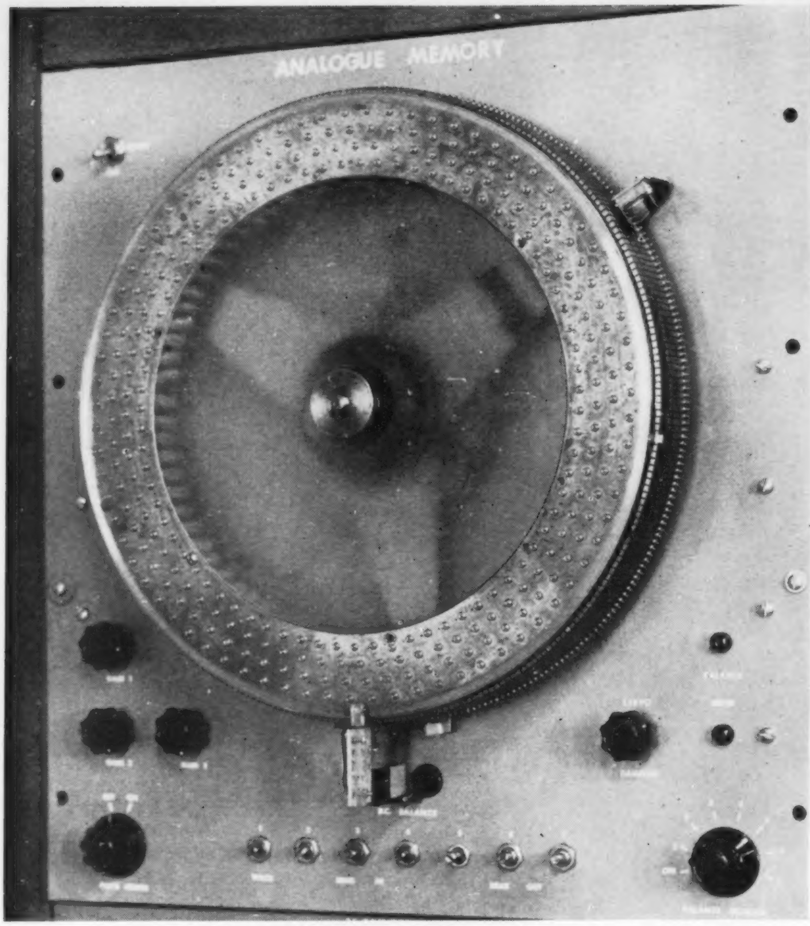
The tape which has been developed for use with this recorder is one mil thick, 2 in. wide and 4,800 feet are contained on a 12½-in. reel. The essential requirements for video tape are a mirror smooth coating with high output, extremely durable base with uniform thickness, and a superior binder capable of withstanding the unusual stresses concerned, manufactured in a factory which is air conditioned and dust free. The tape is then packed in special containers to preserve its cleanliness during shipping or storage.

Those concerned with the developing of this tape were Dr. Wolf Wetsel, Chief Physicist, Minnesota Mining and Manufacturing Company and Mr. Ed Schmidt, Vice-president, Reeves Sound Craft. Mr. Howard Chinn,* Chief Engineer CBS, has been working closely with them. CBS has been using the Ampex Recorder since November 1956 and other networks have done so since April 1957.

END

* Status of Video Tape in Broadcasting by Howard Chinn in SMPTE Journal, August 1957.

Fig. 4. Effect of improperly adjusted head to tape pressure is shown on the television screen during playback of test



The analogue memory unit

New job for an old method: capacitor storage used in analogue memory

*W. S. KOZAK P.ENG.

Storage devices have been successfully developed for use with digital computers but so far there has been little need for them in the analogue field. This memory unit was developed to fill that shortage. It uses the technique of charging a string of capacitors to discreet voltage levels, then reading off at a later period. It has undergone continuous environmental and life testing totalling 1000 hours

*Canadian Westinghouse Company Ltd., Hamilton, Ont.

As is readily appreciated by proponents of digital computers, an information storage device is an essential adjunct in the digital computer field. Various devices have been proposed and successfully utilized, these comprising punched cards, punched tape, magnetic tape, magnetic drums, and magnetic cores, all bearing the name of a memory. These devices were found necessary to the solution of scientific problems, due to the very nature of digital computer operation.

Digital processing of information is essentially a step-by-step procedure in which certain discreet items of data are processed in a predetermined order. This implies the

necessity of storing information yet to be used. An analogue computer on the other hand, is usually thought of as a continuous equation solving machine which processes all problem parameters as a whole, all data being simultaneously utilized upon the operation of the master control switch. For this reason, then, analogue storage devices have not received much attention in the past, for the common classes of problems encountered had no requirement for such a device.

Applications

With the exploitation of the analogue computer in the process industries, a necessity was soon determined for the simulation of transport delays. Such a delay arises through the flow of fluids through pipes, in which the parameter under surveillance, such as temperature of mixture content variation, controlled at one point in the system, is sensed at a remote point. The transport delay between these two points depends on the rate of flow of the liquid and physical separation. The simulation of this phenomenon on an analogue computer using operational amplifiers has several serious shortcomings inherent.

First, too great a number of amplifiers are used up for the delay portion of the problem leaving only a fraction for the rest of the problem. The solution to this, that of simulating the actual problem transfer-functions or equations and then using the amplifiers left over for the system delays, is obviously a poor one. Only very few amplifiers are usually left over and the delays end up being approximated very coarsely or forgotten. Secondly, unless large numbers of amplifiers are used, the frequency response is very poor. Roughly, a four or five amplifier delay unit is only good to about one cycle per second. And slowing down the time scale of the problem may be inadvisable. Thirdly, as is usually found to be the case, the delay time must be made variable electronically according to the specific process one is simulating. This would involve pot-driven servos and more amplifiers.

Analogue computer studies of statistical problems usually require the evaluation of auto and cross-correlation functions. These functions are concise expressions describing random signals and essentially describe how the signal compares with the same signal displaced in time.

The expression for an auto-correlation function is:

$$\varnothing = \lim_{T \to \infty} \frac{1}{2T} \int_{-T}^{T} f_1(t) \cdot f_1(t+\tau) \cdot dt$$

where f_1 (t) is the random signal

f_1 (t + τ) is the delayed random signal

τ is the delay time

T is the integrating period.

A basic analogue diagram for the evaluation of this function is shown in fig. 1. The multiplier and integrator are standard analogue computer components. The missing link in this picture is the storage or delay device.

The application of a storage device to the solution of partial differential equations holds some promise. A finite difference technique is indicated, in which the function in question is sampled over a series of time intervals, obtaining successively new values of the function which are then used as forcing functions for succeeding computations.

Magnetic tape methods

A few magnetic tape recorders may be adapted or designed for this purpose but the problems involved in providing variable delay features are quite severe. If such artifices as changing tape speed or cartridge-to-cartridge spacing are adopted during a run, we meet the problem of a sort of Doppler effect with modulation frequency being changed as a result. If, as is usually the case, frequency or pulse modulation is used this means the actual signal level is correspondingly changed, unless special compensating circuitry is incorporated. And magnetic-tape experts say that amplitude-modulation is undesirable as the residual noise level on tape or magnetic drum is very high. Their solution is to saturate the tape at a constant level and go to FM or pulse. Which brings us back to where we started.

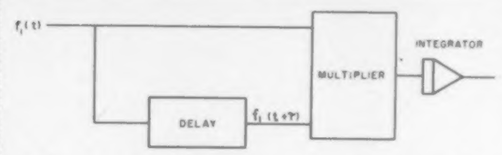


Fig. 1. Analogue diagram for the evaluation of correlation functions.

Capacitor storage method

As so often happens, an old established method of doing a new job sometimes turns out remarkably well. The technique of charging a string of capacitors to discreet voltage levels and then reading-off the levels at a later period in time has found various applications. The unit here to be described utilizes this basic concept for capacitor storage of analogue signals. Shown in fig. 2 is the basic configuration of the Canadian Westinghouse Memory Wheel. A series of commutator bars are arranged along the periphery of a perspex ring. To each of the bars is attached a high quality capacitor, the other ends of the capacitors being terminated on a slip ring. The analogue signal is fed into the wiper at the top and charges up the capacitors to levels equal to the value of the analogue signal at the time a particular capacitor is beneath the upper wiper. If the wheel is made to rotate at a constant speed, each of the capacitors is charged-up in turn in a staircase approximation of the input signal. The grounding wiper at the bottom simply provides a return path for the capacitors. The "out" wiper at the left samples the capacitor voltage levels at a later period in time as determined

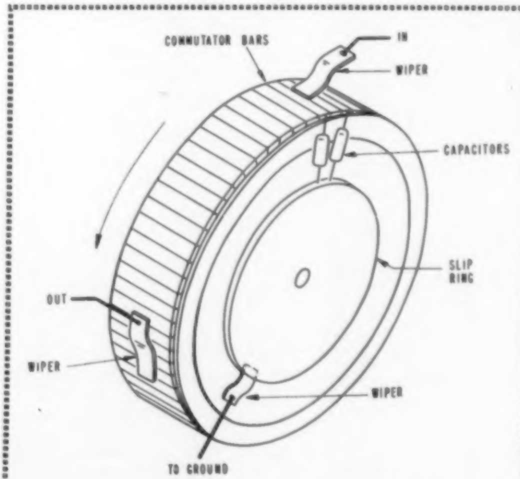


Fig. 2. Sketch of the memory wheel

by the speed of the wheel and its angular displacement from the first, and feeds the delayed signal back into the computer.

From information theory, a definite relationship exists between the frequency content of a wave form and the minimum rate it may be sampled for its faithful reproduction at the other end. This theory states that if the highest signal harmonic is fsig cycles per second then the sampling rate should be at least twice this value, i.e. fsamp = 2 fsig. Or, the sampling interval equals the reciprocal of this figure. Having decided upon an upper limit of 10 cycles per second for our signal frequency we arrive at a sampling period of 1/20 of a second. Furthermore, from an appraisal of the delay times found in typical Analogue Computer Studies, it was decided to limit the maximum delay time to 10 seconds. Thus, the total number of samples should be 200, which theoretically fixed the number of capacitors in the wheel at 200, if a perfect low-pass filter following the sampler were available. Practical considerations resulted in the necessity for using a 50% greater number than this.

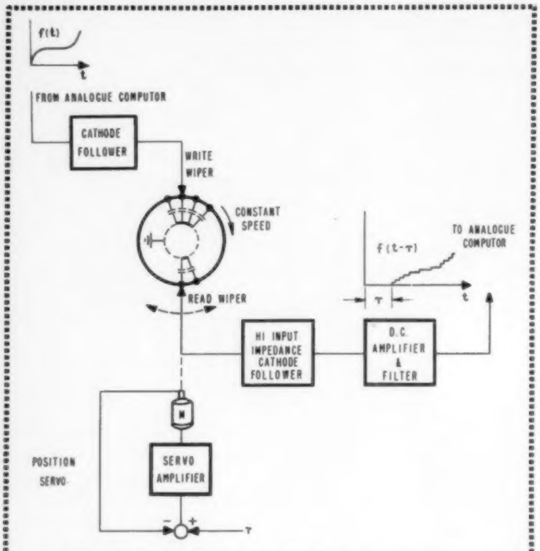


Fig. 3. Block diagram of the memory unit

Development model

The photograph is of the development model of the Memory Unit, containing three output wipers, each with its own electronics, providing up to three delays of the one input signal. Variable delay properties result through servo-positioning the output wiper assembly as a whole. The servo-motor is fed by an analogue voltage corresponding to delay time τ. Each wiper may be preset manually from the others at the start of the problem.

Fig. 3 contains the block diagram of the Memory Unit. The signal to be delayed, f(t), feeds a cathode follower and then the fixed "write-wiper." The cathode follower was found necessary for two reasons. First, some sort of isolation is necessary between the capacitors and the operational amplifiers of the analogue computer. The operational amplifiers of some computers tend to oscillate with capacitive loading. Second, a low impedance output is necessary to bring the capacitors up to charge quickly. The "read-wiper" shown at the bottom of the wheel feeds a high input impedance cathode follower, a d-c amplifier, and a low pass filter. A high input impedance is necessary at the "read-wiper" to ensure negligible discharge of the capacitors during the "reading" period.

A value of about 25 megohms was found to be adequate. The d-c amplifier brings up the over-all gain of the system to unity, and the low pass filter set to cut-off at 10 cycles per second smooths out the staircase effect of the output wave-form, f(t —τ). The delayed signal f(t —τ) may then be fed back into the computer as required. The position servo at the bottom positions the "read-off" wipers along the wheel. The input signals are shown at the top of both graphs with the delayed signal at the bottom.

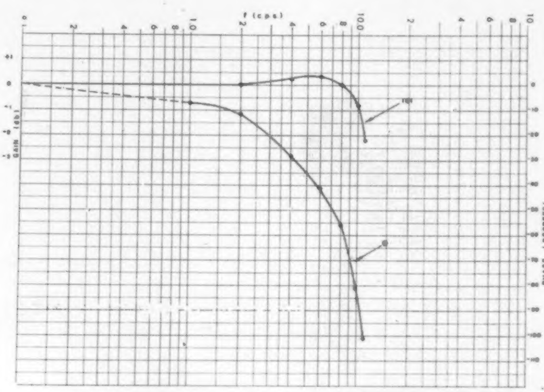


Fig. 4. Signal transmission G, at zero delay setting

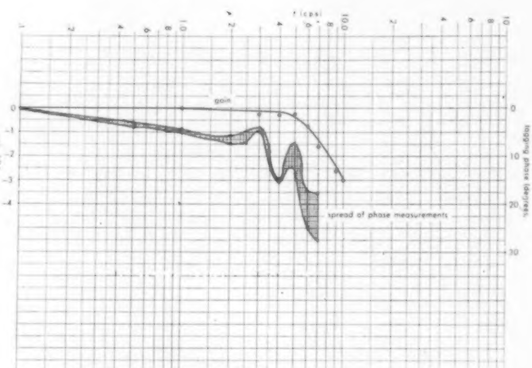


Fig. 5. Frequency response of delayed signal

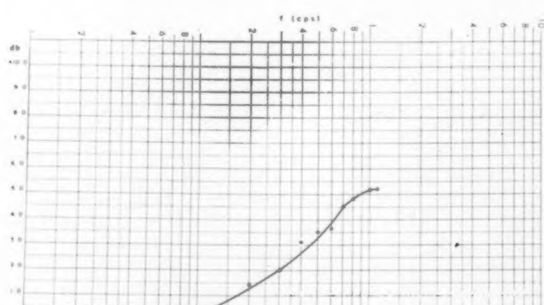


Fig. 6. Pickup arm servo amplitude characteristics, input level 0.2 v rms

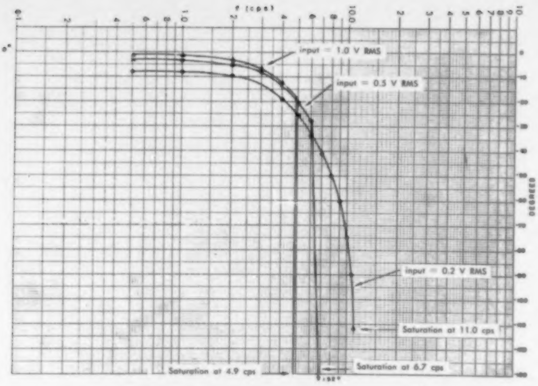


Fig. 7. Pickup arm servo phase characteristics

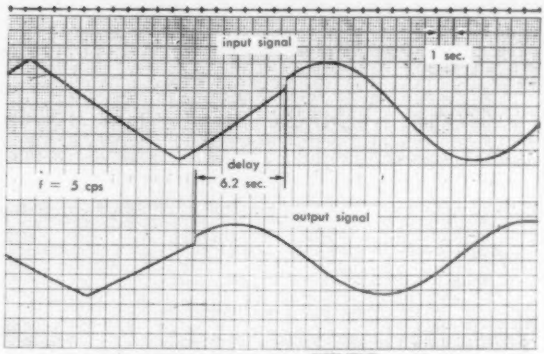


Fig. 8. Signal waveform changed abruptly from sinusoidal to triangular

Frequency response characteristics

To assess transmission characteristics of both the unit proper and the servo portion, frequency responses were obtained, resulting in the curves of figs. 5 to 8 inclusive. Fig. 4 was obtained for zero delay with the output wiper aligned with the input wiper. These characteristics result essentially from the low-pass filter (a quadratic-lagging type was used), modified slightly by the electronics. Fig. 5 includes the effects of sampling action which results in some modification to the gain and phase. Analysis of bit-by-bit sampling action shows that a basic leading phase characteristic results, with phase angle dependent on the points at which the input signal is sampled. This results in a random phase characteristic whose upper and lower limits are governed by the sampling interval. Combined with the lagging characteristic of the low-pass filter, a net phase difference results which is fairly small, as seen in fig. 5.

The servo characteristics as shown in figs. 6 and 7, illustrate an acceleration saturation characteristic. For linear response, the demand for acceleration must not exceed 935 volts rms./sec^2. At low inputs, the servo has an undamped natural frequency of 10.6 cps, and a damping ratio of 0.3. The damping may be varied by a front panel control.

Wave-form reproducibility

Shown in figs. 8 to 15 inclusive are recordings of various signals stored and delayed by the Memory Unit. Figs. 8 to 13 are self-explanatory, showing results of various input wave-form changes for a constant delay setting of

Graphs show stored signals

Waveforms on these two pages and on the one following show both the transmission characteristics of the unit and servo portion (figs. 5-8) and recordings of various signals stored and delayed by the Memory Unit (figs. 9-15)

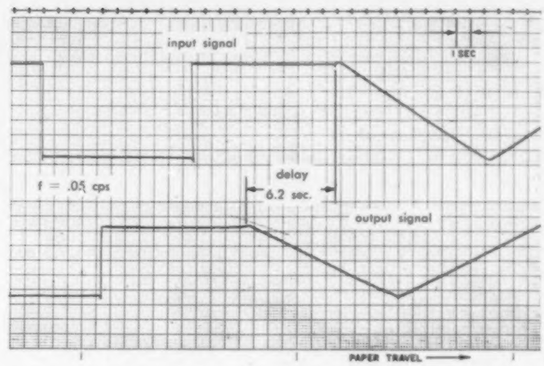


Fig. 9. Signal waveform changed abruptly from triangular to square

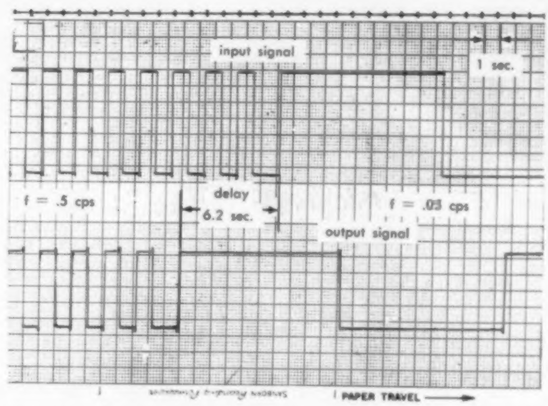


Fig. 10. Square wave signal frequency changed abruptly from .05 cps to 0.5 cps

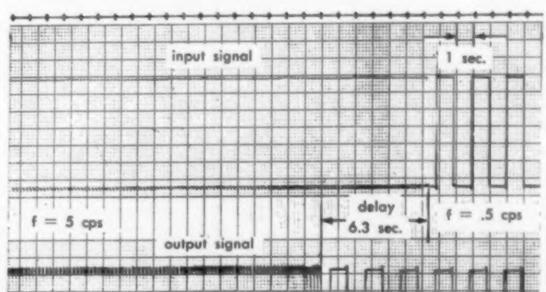


Fig. 11. Square wave signal frequency changed abruptly from 0.5 cps to 5.0 cps

6.2 seconds. Variable delay features are illustrated in fig. 14 where the position servo was fed by a voltage creating a constant wiper acceleration of 4.57 degrees/sec^2. It should be pointed out that the resulting change to the signal frequency is not the deleterious effect common to magnetic tape methods but results through varying delay time as illustrated in the following:

If $f(t) = \sin [wt]$

then $f(t + \tau) = \sin [w(t + \tau)]$

Furthermore, if delay time τ is subjected to a constant acceleration, $\tau = Kt^2$ where K is a constant,

then $f(t + \tau) = \sin w(1 + Kt)t$

where $f(t)$ is the input signal

$f(t + \tau)$ is the delayed signal

τ is the delay time.

Equation 1 shows that a linearly increasing angular frequency results for positive K.

Fig. 15 shows the unit's response to a square wave signal delayed by 5 seconds. A 7% overshoot and a 5° tilt to the leading edge of the square waves result. The possibility of reducing the overshoot by increasing the time constant associated with the capacitors was abandoned in view of the over-riding consideration of maintaining fast charging times. In view of the specified band width of the system (0 to 10 cps), a 0.6 cps square wave which contains harmonics far in excess of 10 cps reproduces remarkably well, especially when compared with results obtained by using analogue operational amplifiers.

Conclusions

The Memory Unit was developed to fill an important shortage in the analogue computing field. At the time of writing no comparable item was found to exist in the market. It has been installed as an integral part of the Canadian Westinghouse Computation Laboratory and has undergone continuous environmental and life testing totaling 1,000 hours of trouble-free running time. It was originally designed for inclusion in a PACE computer rack but is compatible with other types of computers.

The wheel is 14 in. in diameter and the complete chassis fits into a standard 19 in. rack. Power for the unit is drawn from the main computer racks and requires a minor amount of cabling. The voltages required are the ht which may be from ± 250 to ± 300 volts d-c, negative 100 volts reference and 6.3 volts a-c for filaments. The wheel rotates at a constant speed of 6 rpm although a gear interchange assembly for other speeds is contemplated. This would enable an extension of the frequency limit of the unit but with a corresponding drop in maximum delay times possible. For this speed of 6 rpm a maximum delay of 10 seconds and no theoretical minimum delay is possible. However, practical positioning considerations restrict minimum delays to 1/30 of a second. Adjustments in delay are continuous and not multiples of commutator bar spacing. The unit as stands can delay signals up to 10 cycles per second, with negligible attenuation, with an accuracy of one percent. END

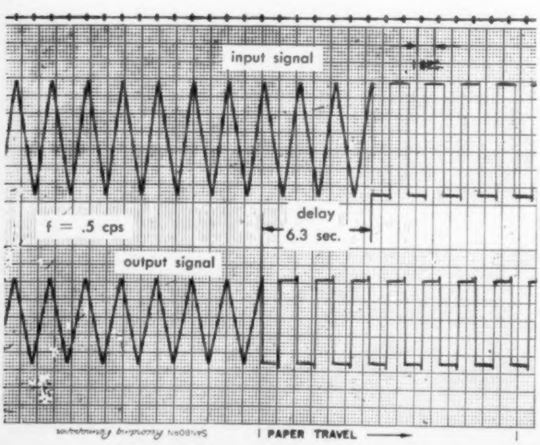


Fig. 12. Signal waveform changed abruptly from square to triangular

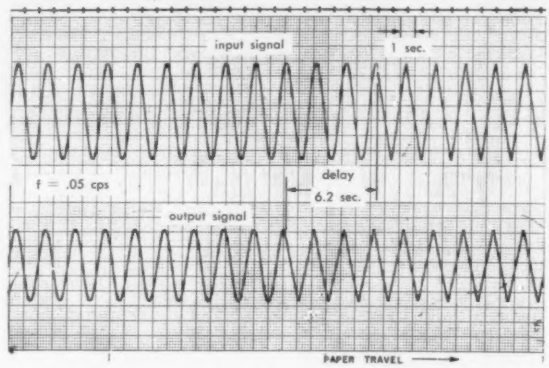


Fig. 13. Signal waveform changed abruptly from triangular to sinusoidal

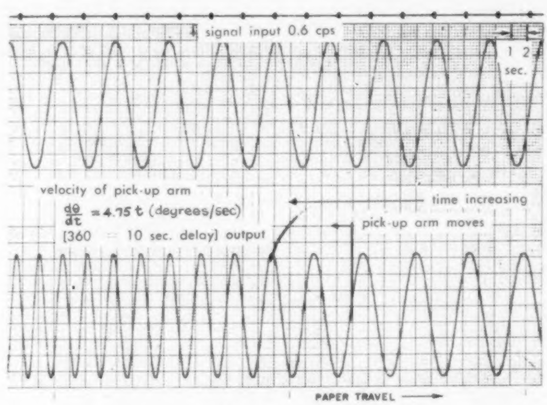


Fig. 14. Effect of varying the delay as the square of time at a rate of .127 sec delay per second. Input signal 0.6 cps

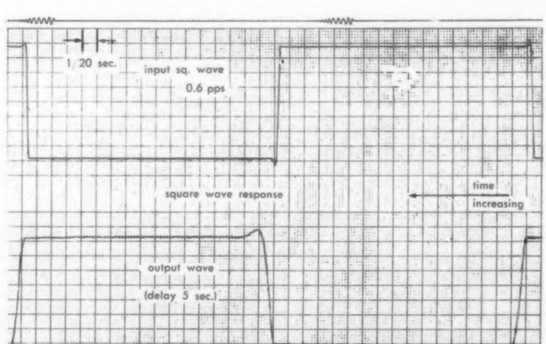


Fig. 15. Response to a delayed square wave input signal

CEE asks the vital question

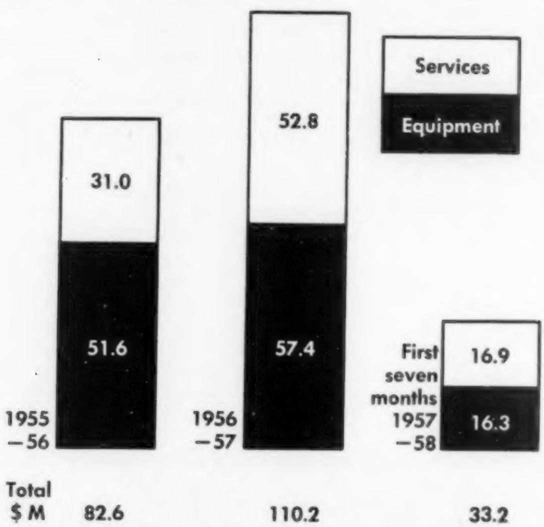
How DDP electronics money is spent in Canada

The Canadian electronics industry is statistically puzzled. When Canadian Electronics Engineering's editors made an over-all survey for the Industry Review and Forecast issue (January '58) they found plenty of figures available—but rarely did they match up.

One major problem was that while totals for Department of Defence Production had been issued few executives had a clear idea of how they were broken up. So the question was put to DDP:

How are you spending money, electronically, in Canada?

Through the co-operation of Director D. B. Mundy of the Electronics Division and his associates these figures can now be published. They are of vital importance and interest to the industry as a whole.



Value of Expenditures Against Contracts for Electronic Equipment and Services Placed in Canada by the Department of Defence Production on Behalf of the Department of National Defence

EQUIPMENT

	1955-56	1956-57	7 months 1957-58
	(thousands of dollars)		
Fire Control, computing sights and devices, and designating and indicating equipment	2,117	376	22
V.T. Fuses	2,370	3,005	688
Guided missile components and remote control systems	—	652	295
Telephone and telegraph equipment	1,307	2,570	965
Radio communication equipment	11,990	11,622	2,961
Radio navigation equipment	1,446	1,250	386
Sound recording and reproducing equipment	647	921	52
Radar equipment	13,670	10,746	2,804
Underwater sound and detection equipment	3,646	4,378	1,602
Other communication equipment including cryptographic equipment, teletype and facsimile equipment, intercommunication and public address systems, visible and invisible light communication equipment, radio and radar countermeasure equipment	1,871	4,461	780
Electron tubes, transistors and rectifying crystals	2,284	3,880	848
Antennae, waveguides and related equipment including aerial, mast and tower equipment	685	3,358	898
Synchros and resolvers	32	3	85
Other electrical and electronic components, including resistors, capacitors, filters and networks, switches, electrical connectors, relays, contactors, solenoids, coils, transformers, headsets, handsets, microphones, speakers	3,053	3,714	1,424
Electrical control and rectifying equipment	395	350	311
Electrical converters, including dynamotors, motor converters, motor generator sets, phase converters, synchronous converters	1,798	423	79
Electrical and electronic measuring and testing instruments	1,982	2,657	677
Hazard-detecting instruments and apparatus, including radiac equipment, gas detecting equipment, land mine detecting equipment	86	153	13
Flight simulators	1,931	2,857	1,369
Other training devices	277	32	3
TOTAL	51,587	57,408	16,262

SERVICES

	1955-56	1956-57	(7 months) 1957-58
	(Millions of dollars)		
Repair, overhaul, maintenance	4.6	5.7	5.3
Design, development	4.3	2.9	0.5
Rentals, charter aircraft	4.6	11.0	3.7
Construction, installation, etc.	0.8	5.2	1.1
Professional services	16.7	28.0	6.3
TOTAL	31.0	52.8	16.9

For your library

All the designer needs in new electronics handbook

Electronic designers' handbook

Robert W. Landee, Donavan C. Davis, Albert P. Albrecht. McGraw-Hill Book Company, Inc.; $19.80.

This book is everything its title says. Physically a massive book it covers the field in a thoroughly comprehensive and up-to-date manner. It gives fundamentals and data to aid in the design of all types of electronic equipment.

Many of the circuits used by engineers are covered, with theoretical and technical discussions and explanations, design examples to show application of theory, and graphical and tabular data needed in day-to-day design work. The text is lucid and the material self-explanatory, being well illustrated by design examples. In fact there are over 1,100 figures, 1,400 equations and 140 examples in the book.

The entire electronics field is covered under such headings as vacuum tubes and transistors, voltage amplifiers, modulation, oscillators, clippers, limiters and clamps, trigger circuits, attenuators and equalizers, waveform analysis, network analysis and many others.

The book is undoubtedly a "must" for students and practicing engineers in electronics. It is one of the most comprehensive books covering the whole field to have been published in recent years.

The new High Fidelity Handbook

Irving Green and James R. Radcliffe. Crown Publishers Inc., New York; 193 pp; $4.95.

This is a first class guide to the world of high fidelity. It is both technical and practical in that it provides a lot of detailed performance data and information on what to look for in various systems together with illustrations and details of equipment actually available from various manufacturers.

It goes into both disc and tape recording systems and has a comment to make about the use of radio tuners in high fidelity networks. Probably one of the best sections is on "reproducing the amplified sounds." A lot of jargon has been written about loudspeaker systems and over the years they have tended to become more and more complicated with very little gain for the extra money and time involved.

This section goes into the problems of the loudspeaker very deeply and gives some practical designs for cabinets. Later in the book, under "Making High Fidelity Furniture" and following sections, it gives plans and details of speaker cabinets to fit almost everyone's need.

The book also has some comments from some of the outstanding amplifier designers. This comment from Harold G. Leak Company in England is interesting: "By October 1945 I was advertising a four-stage feedback amplifier using push-pull KT66's for which I claimed a distortion of 1% at 10 watts . . . 18 months later a very similar four stage circuit by Williamson was published. Both these four-stage circuits had margins of stability which in my opinion were not sufficient and the obvious solution was to improve the phase characteristics by omitting one stage . . . this was accomplished by replacing the conventional phase splitter valve by a circuit having a gain seven times as great and by replacing the input triode tube with a pentode. The distortion measured by the National Physics Laboratory was .03% at 10 watts output."

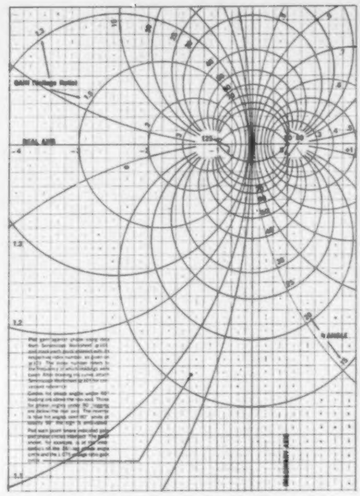
This really was an achievement.

Servosystems Laboratory Manual and Servoscope Worksheets

The 32-page illustrated Servosystems Laboratory Manual prepared by the Educational Services Dept. of Servo Corp. provides the structure for laboratory experiments to extend progressively the student's knowledge of servomechanisms, feedback control systems, and related topics. Price: $2.

Servoscope Worksheets provide a method of dynamic analysis by recording and plotting the phase and amplitude characteristics of any servo component or system as indicated by the Servoscope Servosystems Analyzer. Each worksheet is an Ozalid master from which working copies can be made.

Worksheet No. 101—A table for test data, supplying conversion equivalents; Worksheet No. 102—Bode and Nichols diagrams for open-loop testing; Worksheet No. 103—Nyquist diagrams for open-loop testing; Worksheet No. 104—Complex plane conversion chart for open-loop response from closed-loop data. Free of charge. Measurement Engineering Ltd., Arnprior, Ont. (101)



Servoscope worksheet No. 104

Catalogues and brochures from the manufacturers

Laminated plastics and vulcanized fibre application and engineering data. Eight-page catalogue includes data tables itemizing specifications, dimensions, colors and applications. Taylor Fibre Co., Norristown, Pa. (102)

Electronic Engineers Master—EEM catalogue, 1958 edition will debut at I.R.E. Show in New York. The 1,000-page volume lists products of over 300 manufacturers. United Catalog Publishers, Inc., Hempstead, N.Y. (103)

Collins Broadcast Transmitters and accessories. 28-page catalogue. Collins Radio Co. of Canada, Ltd., Toronto. (104)

High Fidelity catalogue No. 5/3 lists 40 pages of audio equipment. Electro Sonic Supply Co. Ltd., Toronto. (105)

Nultrax electronic machine tool control unit is described in 12-page booklet. Canadian Westinghouse Co. Ltd., Hamilton. (106)

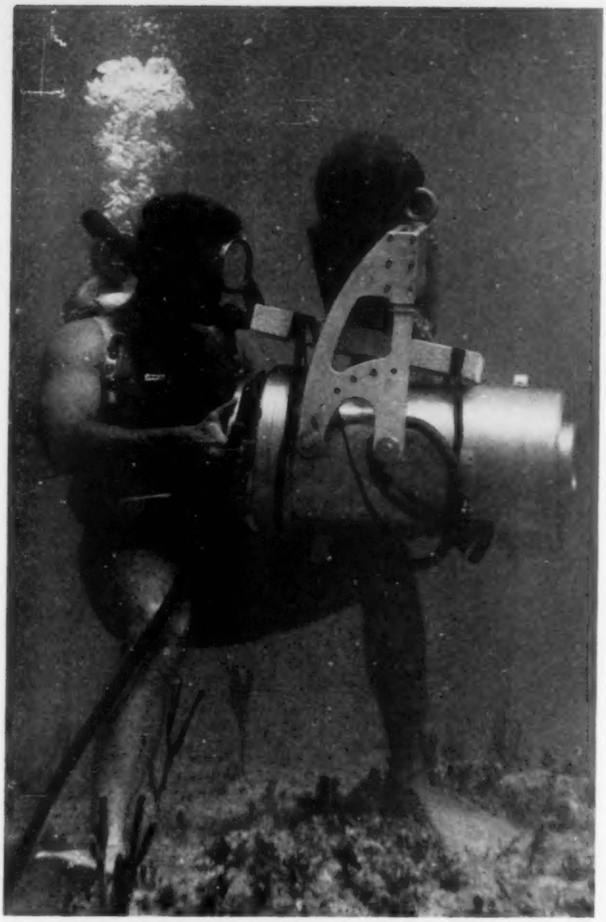
Product Pioneering slidefilm kit contains 92 slides, LP record, text, script, and handbook titled Finding, Screening and Appraising New Products (25 copies). Kit price is $135 ($95 to AMA members). American Management Assoc., New York. (107)

Ampex Digital Tape System. 16-page brochure lists features and specifications of digital tape equipment. Ampex American, Toronto. (108)

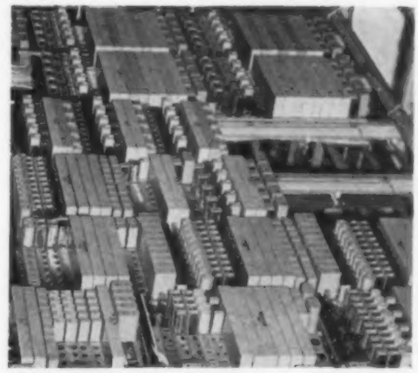
Ultrasonic machining is explained in 24-page booklet illustrated with photos, drawings and graphs. Philips ndustries Ltd., Toronto. (109)

High frequency capacitors, water cooled, class HF, 500 to approx. 12,000 cps. Bulletin GEC-1346B includes performance data on 53 separate ratings. Canadian General Electric Co. Ltd. (110)

TV probes the strange world under water



Skin diver aims Pye underwater tv camera during tests of new marine equipment



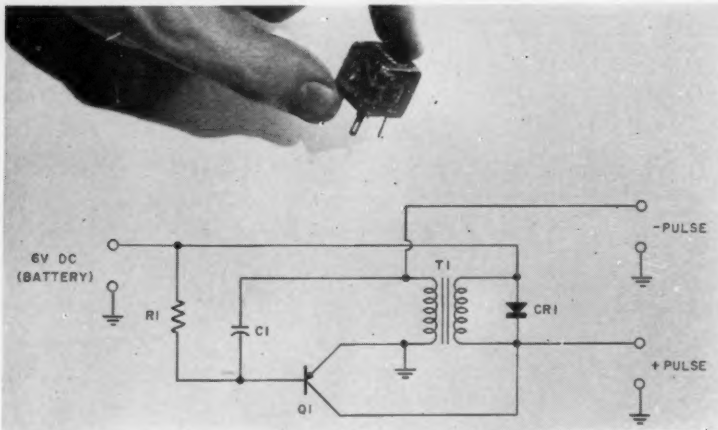
Where was this taken? A slight twist of the head may solve vystery

Suit diver checks Pye tv camera before taking it down to inspect lower part of a dock. Engineers at monitor checked condition of foundations as diver aimed camera

Bell Telephone technician works in crossbar canyon, adjusting the direct distance dialing equipment

New products

Blocking oscillator molded in three quarter inch cube



Encapsulated within ¾-in. molded cube (epoxy resin) is a complete blocking oscillator circuit which includes a subminiature Du Mont pulse transformer, transistor, capacitor, resistor, and crystal diode. The circuitry, described in the schematic, produces triggering electronic pulses.

Designated the Du Mont Pulse Cube, the pictured unit produces a pulse of three microseconds duration with a rise time of 0.06 microseconds. This unit which has a repetition rate of 25 kc can run on a miniature six-volt mercury cell for approximately 1,000 hours. Amplitude of pulse is from +6 volts peak to —3 volts peak. Variations of the Pulse Cube are available with a fixed repetition rate of 1 kc, or a variable repetition rate from 400 cps to 24 kc. Operating temperature range is from —55 deg C to 60 deg C. They are available either as free running blocking oscillators or as external trigger types, and can be furnished either as plug-in units or solder lug types.

Bayly Engineering Ltd., Ajax, Ont. (111)

UHF transmitter delivers 250 w at 450-460 mc

Engineered to deliver up to 250 watts, this uhf base station radio transmitter may be licensed for operation in the 450-460 mc band. All components and test points are readily accessible from the front or the rear of the unit. No hazardous voltages are exposed when the front door is open. Power output is measured by a built-in test meter and failure of any major circuit in the equipment is signaled by an indicator light or by an abnormal meter reading. For continuous duty stations and repeaters, cabinet ventilation is provided by a thermostatically controlled blower.

Canadian General Electric Co. Ltd., Toronto. (112)

Silicone varnish bonds electrical insulation

R-610 silicone varnish has been developed for coating and bonding Class H electrical insulation components. It contains 65% silicone solids in xylene, yet has a viscosity of only 75-175 centipoises. This low viscosity provides the penetrating and wettability properties of the varnish. Other advantages are fast drying time, high dielectric strength, low water absorption, and little weight loss upon curing and aging. It can be used to bond mica splittings in many mica tape combinations. It can also be used to coat glass cloth on conventional coating towers. In addition, R-610 can be used as an adhesive for bonding various other types of electrical insulation components. R-610 is available in 20-oz., 2-qt. and 1-gal. bottles, and in 5 and 55-gal. drums.

Bakelite Company, Toronto. (113)

Electronic weighing reduces cost

Low maintenance costs are one of the advantages claimed for electronic weighing apparatus using strain gauge load-cells. Since there are no moving parts the apparatus is not subject to wear through contamination or abrasion. Weight is accurately recorded by an electrical signal transmitted by the load-cells to a strip chart recorder or large dial indicator. Card and tape printing devices are also available.

Philips Industries Limited, Toronto. (114)

E-type negative impedance repeaters

Pye Canada Limited are now marketing the Hallamore E-Type negative impedance repeaters which are designed to compensate for transmission losses in exchange cables.

Using either a-c or d-c type tubes, the repeaters employ an amplifier and network which counteracts and compensates for conditions which cause the transmission losses. These are available for both series and shunt connections.

These repeaters are interchangeable with Western Electric E-2 and E-3 series type repeaters. Bell System standard practices for use of E-Type repeaters are directly applicable to Hallamore negative impedance repeaters.

Pye Canada Ltd., Toronto. (115)

True motion marine radar

True motion marine radar equipment can now be installed into all existing Marconi radars aboard ship. This transistorized development has a power consumption of 40 watts and measures only 9x14x18 in. Cost has also been reduced to approximately half that of previously developed true motion equipment. These features make it possible to install true motion radar on all classes of vessels.

Canadian Marconi Company, Montreal. (116)

Composition fixed resistors

Coldrite 70+ fixed composition resistors are made by a cold-mold process that assures uniformity in production. The resistors are available in MIL-R-11B styles RC-20 (½ watt), RC-32 (short 1 watt), and RC-42 (2 watts). Resistance tolerances of 5%, 10%, and 20% can be furnished in all EIA preferred resistance values.

Canadian Stackpole Limited, Toronto. (117)

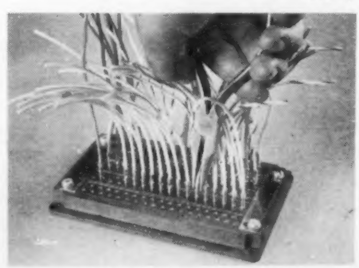
Versatile connector panel assembly

A high degree of flexibility in connections makes the taper-pin panel assembly suitable for circuit testing and development. Versatility is achieved with an aluminum frame in which shielded panels are snapped and locked. The frame will accommodate as many as eight standard panels but special frames and panels can be made.

The panels use the new "Stapin" solderless taper pins which are crimped on cable sizes from No. 28 through No. 12. The sockets are molded into the panel.

Insertion of Stapin-terminated wires into the panel is facilitated by an insertion tool in which the pin is locked by a twisting action and from which it is released only when the insertion cycle is completed. Uniform tool controlled impact secures the pin in the panel socket from which it can be removed with a pair of needle-nose pliers.

Burndy Canada Limited, Toronto. (118)



(Continued on page 47)

Eleven column recorder

The Hewlett-Packard Model 560A Digital Recorder prints 11 column digital information at rates to five prints per second. Although primarily designed to make a permanent record of electronic counter read-outs, the manufacturer states that the 560A can be used with two or more counters simultaneously, digital voltmeters, time recorders, flow-metering equipment and systems, such as telemetering installations and engine test stands.

In addition to the printed tape record, the Model 560A provides an analog current or voltage output to drive a galvanometer or potentiometer strip chart recorder or to provide a servo control.

Atlas Radio Corp., Toronto. (119)

Tetrode for broadband amplifiers

Provisionally named the A-1600, a new tetrode with low output capacitance has been designed for use in broadband amplifiers from audio frequencies up to about 300 mc. Three cathode leads reduce the cathode lead inductance. The close-spaced structure results in small transit time loading. At a frequency of 70 mc the input conductance is approximately 1100 umhos. The special plate design gives the A-1600 pentode-like charactertistics, making it suitable in output stages.

Ericsson Telephone Sales of Canada Limited, Montreal. (120)

Microwave couplers have 40 db directivity

Two series of microwave couplers of three db and six db values cover the frequency range from 2.60 to 18.0 kmc. They have a directivity of 40 db.

The couplers and multi-holed and consist of a primary and secondary line with the coupling holes contained in a common wall. Standard cover flanges terminate both ends of the primary line. One end of the secondary line has a built-in low vswr termination to ensure high directivity. The other end of the secondary arm is terminated with a standard cover flange.

MEL Sales Ltd., Arnprior, Ont. (121)

(Continued on page 48)

New products

Aircraft blade antenna

Type DM-C7 antenna is designed to operate in the 225-400 mc band for use with communication and data link equipment. This antenna is a high-strength swept-back aluminum blade, with a height of 7¾ inches from the aircraft skin, designed for use at speeds well into the supersonic region. The maximum thickness of the antenna is substantially less than 10% of the average chord length.

The antenna has been designed to meet the environmental requirements of MIL-T-5422C and Paragraph 4.12 of MIL-E-5272A. Load tests indicate that the antenna can withstand more than 8 pounds per square inch lateral static load. The weight is approximately 20 ounces and the VSWR is less than 2.5:1.0 over the 225-400 mc band.

Dorne & Margolin, Inc., Westbury, L.I., N.Y. (122)

Wobbler doubles life of image-orthicon tube

Burn-in and sticking of images on image-orthicon tubes are two of the factors limiting the life of the tubes. These can be minimized with the I.O. Guard which is about the size of a cigar box and mounts on the side of the TV camera.

Principal of the new electronic tube saver is an electronic deflecting system used to move or wobble the TV image inside the I.O. tube. Thus burn-in or sticking is avoided. To offset the wobble, a scanning beam inside the tube follows and automatically compensates the wobble, causing the transmitted picture to appear as a normal stationary image on TV receivers. Tests indicate that the tube life can be doubled.

Canadian General Electric Company Limited, Toronto. (123)

(Continued on page 51)

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166	167	168	169	170	171	172	173	174	175	176	177	178	179	180
181	182	183	184	185	186	187	188	189	190	191	192	193	194	195

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Free service for our readers

Keep your reference shelf up to date this easy way. All advertisements, new products and literature in this issue have a key number. For more information ....

- **Circle the key number on one of these cards**
- **Print your name, position, address and firm, then mail — postage is paid.**

Some advertisements cannot be numbered due to lack of space. Their key numbers are, however, given in the advertisers' index

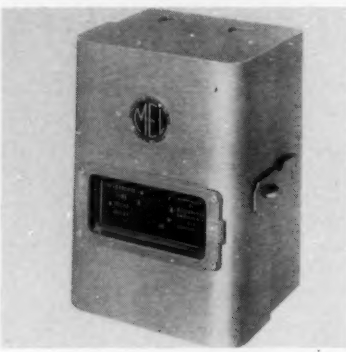
New products—cont.

Four industrial timers

Four Meltrols have been designed for industrial timing applications. Model ET-1 general purpose time delay relay has a range from 1 to 300 seconds with an accuracy ±2% for ±10% change in line voltage. It can be remotely controlled and is designed for machine tool control, internal timing, dielectric heating, heat sealing and photography.

Model ET-2 high speed timer has a range from 0.05 to 2 seconds (2-120 cycles). Repeat accuracy is ±2% for ±10% change in line voltage. It may be used to control resistance welding, X-Ray control, induction heating, and filling operations.

Model ET-3 repeat cycle timer has two ranges, 0.1 to 60 seconds and 0.3 to 180 seconds. Repeat accuracy is ±2% and it can be remotely controlled. It can be used for cycling electrical equipment, programming, life testing and heat cycling.



Model ET-4 general purpose short cycle timer has ranges of 0.04 to 4 seconds and 0.04 to 16 seconds. Repeat accuracy is ±2% and it can be remotely controlled. It was designed for vending machines, molding, presses, machine tool control and washing cycles.

Measurement Engineering Ltd., Arnprior, Ontario. (124)

Miniature switch has ¼ in. over travel

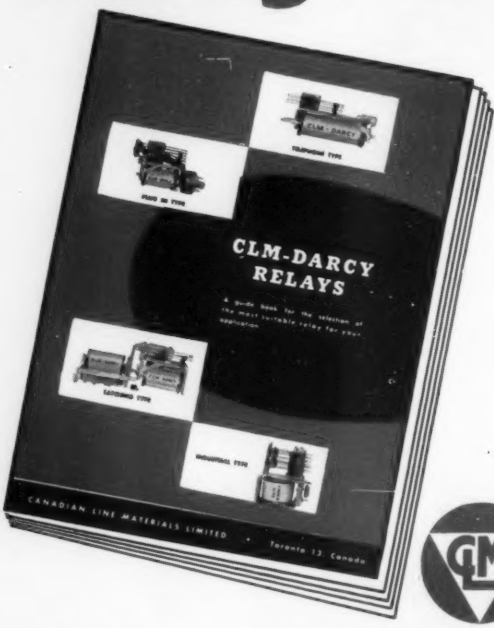
Over travel after actuation on this miniature switch is ¼ in. The number 6132 switch basically consists of two standard Haydon hermetically miniature switches in a dust and moisture proof case and a plunger type actuator. The actuator is spring loaded and operating force can be adjusted to meet individual requirements. A molded rubber sleeve and potting keep the entire assembly, including the actuator, dirt-free.

This type of switch assembly, incorporating any number of standard hermetically sealed miniature switches and an actuator, can be made to specification.

Haydon Switch Inc., Waterbury, Conn. (125)

(Continued on page 53)

How to select relays...



CANADIAN MADE RELAYS — Industrial — Telephone Type—Latching—Plug-in—Micro Switch and Aircraft are illustrated and described complete with Electrical and Mechanical Specifications in this *Brand New* 24 page Catalogue. The coupon below brings a free copy to interested users.

TO: CANADIAN LINE MATERIALS LTD.
TORONTO 13, CANADA
Please send me a copy of CLM-Darcy Relay Catalogue R-58

Name____________________

Title____________________

Company____________________

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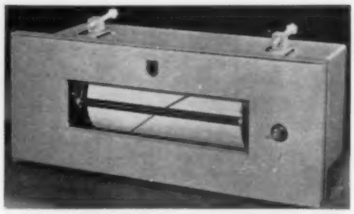
Flexible wire makes programming transmitter universal

The Universal Program Transmitter permits the setting up or changing of a program without the necessity of cutting cams or performing any machining operations. The transmitter consists of a motor-driven cylinder with a flexible bronze wire attached. The wire, which can be bent to any shape in accordance with the desired program, makes contact with a linear wire-wound potentiometer, dividing it into two arms of a bridge circuit. When the drum rotates the bronze wire acts as a contact sliding along the potentiometer. This continually changes the balance point of the control bridge and consequently the set point for the process. Fifteen speeds provide rotations from one cycle per hour to one cycle in six days.

Philips Industries Limited, Toronto. (126)



New carrying cases for Meggers

The new leather stand case (cat. 70294) for the Series 3 Megger insulation tester allows the tester to be used merely by lifting the lid. It also has a compartment to house the test leads. It derives is name from the fact that the lead compartment forms an effective stand that elevates the tester from the bench, allowing full clearance for the generator handle.

R. H. Nichols Limited, Toronto. (127)

Television camera for color

Production will soon start on General Electric's new color television camera which employs printed circuits and transistors to reduce size, improve reliability and facilitate servicing. Three image-orthicon tubes are used to pick up the pictures but a newly developed optical system has eliminated the need for many glass surfaces through which color signals were required to pass. Circuits were designed to ensure truer registration of colors with no blur or runover into other colors.

Hinged panels and plug-in assemblies have been employed to facilitate maintenance. In addition, the camera is equipped with controls and operating features to permit cameramen to make on-the-spot adjustments in color registration. Circuitry in the camera has made it possible to use only a single cable from the camera to the control console.

Canadian General Electric Co. Ltd., Toronto. (128)

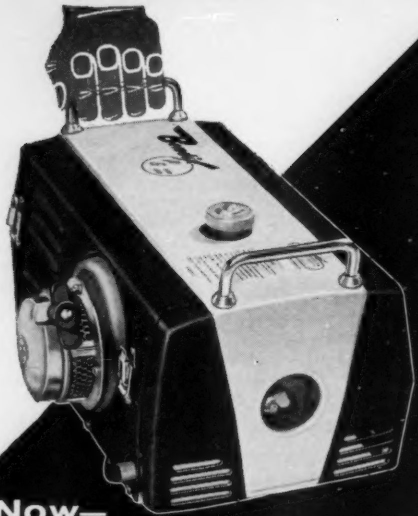
Frequency calibrator is crystal-controlled

Model 521 frequency calibrator has been designed to : Calibrate oscillators and discriminators in fm-fm telemetering systems; provide calibrated input voltage to each voltage controlled oscillator in the transmitting system and measure deviations from standard frequencies; check alignment of each discriminator in the receiving system; allow direct frequency readings in terms of percentage deviation.

The circuitry of the calibrator permits comparison of two frequencies to derive the difference frequency and the sign of the difference without need for frequency restrictions or selective filterin. A stable frequency reference is provided by means of internal crystal oscillator and a set of crystals. All deviations are expressed in percentage of centre channel frequency and are continuously indicated on the meter.

Radionics Limited, Montreal. (129)

(Continued on page 55)



Now—

Portable Electricity for Work or Play

Bendix PORTABLE ELECTRIC GENERATOR

provides electricity for many purposes

Weighing only 55 lbs., this small (19" x 11½" x 13") unit can provide you with modern living wherever you go! Powered by a two cycle, 2 h.p. air-cooled engine, this 110V, 60 cycle A.C. portable generator will produce a power of over 800 watts—enabling you to take your power supply with you. In emergencies, on trips into the bush, aboard boats or as a convenient power source at remote sites the BENDIX PORTABLE POWER GENERATOR is a MUST!

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- ★ For Trailers
- ★ On Boats
- ★ Hunting and Fishing Trips
- ★ Radio Communications
- ★ Home Emergencies
- ★ During Construction
- ★ For Power Tools
- ★ On The Farm

Write for details and descriptive literature.

Dealer Inquiries Invited

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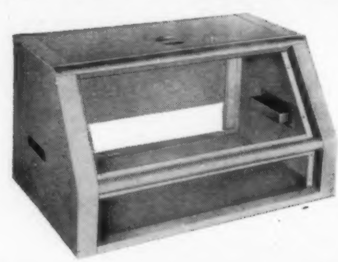
Beauty

that's MORE than skin deep

The gleaming finish on BUD Sheet Metal Products adds eye appeal and utility . . . doesn't hide blemishes. And there's beauty too, in the expert craftsmanship and engineering skills involved. Bud housings, which you can obtain from stock, have innumerable applications in Electronic and Electrical Instrumentations and Controls. It will pay you to investigate the advantages of the hundreds of sizes and shapes we can offer from inventory. Of course, we do special fabrication, too!

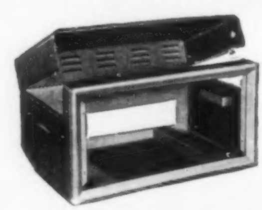
Illustrated are two real Bud "Beauties"! Perhaps they fit into your production picture.

BUD SLOPING PANEL "PRESTIGE" CABINETS



Offer high style, custom appearance at standard stock prices. Hinged, perforated top swings back to provide easy access. Top panel swept back for easy viewing. Panel trim bar is removable to permit easy withdrawal of chassis attached to either or both panels. Available in three sizes.

BUD STANDARD "PRESTIGE" CABINETS



Hinged cover, available in solid or perforated, swings clear of cabinet body. Furnished complete with two supporting channels which can be moved laterally to accommodate any width chassis or mounting platform. Built of 16 gauge steel and flawlessly finished in grey hammertone. Three stock sizes.

Write us for details on the "Prestige" cabinet line or see them at your Bud Distributor.

TENATRONICS, LTD.

Davis Drive, East — Newmarket, Ontario

Exclusive Canadian Representative for

BUD RADIO, INC.

2118 East 55th St. — Cleveland 3, Ohio
Dept. CA

Circle No. 16 on Reader Service Card

Voltage-current calibrator

Model 6020B voltage and current calibrator measures pulse amplitudes. Originally designed for magnetic core testing and grading, the unit is applicable to general pulse, dc and sine wave measurement. Ten ranges cover 0 to 500 v (100 mv full scale on lowest range) and 0 to 1000 ma. Effective zero suppression is provided on the output to allow use of a high gain oscilloscope for accurate comparison.

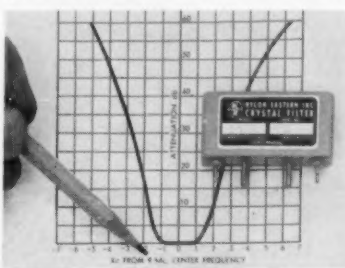
Two variable calibrated reference voltage (.001% stability) and the signal to be measured are sampled and furnished to an oscilloscope for a superimposed display. The two references may be set for tolerance checking or for .5% amplitude measurement by adjusting to the same level as the signal.

Electro-Pulse Inc., Culver City, Calif. (130)

Miniature crystal filters for mobile receivers

These miniaturized symmetrical bandpass crystal filters have been designed for single conversion receivers used in mobile services. Designated model 9MA they measure 1-61/64 in. by 19/32 in. by 15/16 in. high. Centre frequency is 9 mc, passband ripple is less than ½ db; bandwidth at 6 db attenuation is 3 kc, bandwidth at 60 db attenuation is 12 kc, insertion loss is less than 3 db, impedance is 1K nominal.

Model 9MA may be employed at high impedance level to obtain maximum gain with vacuum tube circuitry, or at low impedance level to obtain maximum power transfer with transistor circuitry.



A wide impedance range may be accommodated by the use of resonant circuits.

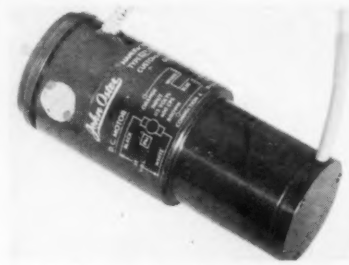
Hycon Eastern Inc., Cambridge, Mass. (131)

(Continued on page 56)

New products—cont.

Motor-tach generator

Newly developed type 15-MTG-6276-02 is a 28 vdc permanent magnet motor driving a tachmeter generator. The tach generator has a frequency range from 380 to 1760 cps at 115 vac input. Output of 1.65 volts minimum at 11,000 rpm min. with 25,000 ohm load, linearity 5% min. up to 5,000 rpm, and phase shift output within 15 deg. of input at 400 and 1600 cycles. Motor input is 28 vdc, rated torque 0.3 oz. in. and brush life 1000 hours. Meets specification MIL-E-5272.



John Oster Manufacturing Co., Racine, Wis. (132)

Twin track tape recorder

Track change-over on the Winston Thoroughbred tape recorder is done by pushbutton rather than turning the tape over. It has two high impedance record-playback heads, two low impedance erase heads, drop-in tape loading, pause control, servo braking and spool locking, fast rewind in both directions, and other features. The three tape speeds are 15, 7½, and 3¾ ips.

Frequency response at 15 ips is 50 to 16 kcs; at 7½ ips it is 50 to 12 kcs; at 3¾ ips it is 50 to 7 kcs. Wow and flutter level is better than 0.1%.

Two input sockets accept a microphone and a record player or radio tuner signal. Output of the amplifier is four watts which can be switched to external speakers or the three internal speakers.

Mechron Engineering Products Ltd., Ottawa. (133))

Detector-power amplifier tube uses 12 volts

Type 13DL8 is a miniature nine-pin combined twin diode and space grid tetrode with independent unipotential cathodes. It has been designed for use in modern automobile radios.

The diode section is intended for use as a detector while the tetrode section is a power amplifier to drive the transistor audio output stages. All tube elements, including the heater, operate at a potential of 12 volts obtained directly from the automobile battery.

Sylvania Electric Products Inc., New York. (134)

Advertisers' Index

Want More Information?

If you wish to obtain further information on any of the advertisements or editorial items appearing in this issue, please make use of our Reader Service card on pages 49 & 50

Members of the Canadian Radio Technical Planning Board who met in Ottawa recently

New approach may beat problems of direct heat conversion

New approaches to the problem of converting heat directly into electricity are being made by the General Electric Company. One of "several promising investigations" is a thermionic converter. Experimental models have changed more than eight per cent of the applied heat energy into electric power.

Most previous methods of converting heat directly into energy—without rotating machinery—have been based on the thermocouple, but the efficiency is normally below one per cent.

In the thermionic converter the metals are separated by a gas at very low pressure. There is an electrical flow between the electrodes, but there is less flow of heat than through a metal. Thus the electrodes can be at different temperatures and the efficiency is greatly increased.

It is hoped that thermionic converters may ultimately be able to change more than 30 per cent of heat energy directly into electricity.

New iron material

GE scientists also report a new material "four-square" silicon iron, which permits easy magnetization in four directions and makes possible reduced energy losses and "noise."

Singly orientated materials can be magnetized in two directions, back and forth lengthwise along the sheet. The doubly orientated "four-square" effect is produced by alignment called "cube-texture" which gives excellent magnetic properties not only back and forth along the sheet but also back and forth across.

A.D.P. CUTS DOWN PAPER WORK

It seems evident that we who devote our lives to electricity must not only keep pace with automation, but should promote it and where necessary defend it . . . In 1946 electrical manufacturing needed about 25 clerical and management people for every 100 producing workers. Today we need about 60.

One of the most promising sources of relief for the office productivity problem is automatic data processing. In this field we are on the threshold of what is virtually another industrial revolution.

In ten to 15 years it is probable that many clerical offices in accounting, purchasing, production and order service departments will consist of a bank of computing machines operated by only a few highly skilled technicians, thus freeing thousands of men and women from routine jobs for more productive work.

. . . Quotes from a speech by George L. Wilcox, president, Canadian Westinghouse Co. Ltd.

Solving problems of transistor surfaces

Transistor techniques are still in their infancy. Among problems in the manufacture are those associated with surface technology where a thin film of oxide may lead to serious degradation of initial performance and long-term reliability.

Work has been going on into problems at the Bell Laboratories and in the March issue of Canadian Electronics Engineering C. G. B. Garrett deals with them in an article "Research into transistor surfaces helps improve reliability."

Associate Editor Ian Dutton writes on the importance instruction books play in building up customer goodwill and there will be an article on Sonograph's special three-channel recorder.

Toronto station steps up FM interest

Canada's only all-FM station, CHFI-FM in Toronto, is campaigning on its first anniversary to find out where listeners live, and what they think of the daily programs.

It is estimated that in the area around Toronto served by the station there are 50,000 FM radios. Sales of kits and completed sets are running at a particularly high level, one dealer reporting the sale of 1,000 in the last quarter of 1957.

The station broadcasts on 98.1 mc with a power of 9,450 watts. It has a General Electric transmitter, type BT-1-B and the station has designed and built its own serrasoid phase modulator which, with its high frequency response, can transmit mute and restore signals over 22.5 kc.

These are used in the station's service of background music to food markets and stores. When news, or advertising not required by the stores, is broadcast the store receivers are muted, then restored afterwards.

COMING EVENTS

February

2-7 AIEE Winter General Meeting. New York.

20-21 AIEE-IRE-U of P Transistor & Solid State Circuits Conference. Philadelphia.

March

17-21 EJC Nuclear Congress. Chicago.

24-27 Radio Engineering Show & IRE National Convention. New York.

April

14-16 AIEE-IRE-ASME Automatic Techniques Conference. Detroit, Mich.

14-17 15th Annual Radio Component Show. Grosvenor House and Park Lane House, London, W.1.

16-25 Instruments, Electronics & Automation Exhibition. Olympia, London.

May

12-14 National Aeronautical & Navigational Electronics Conference. Dayton, Ohio.